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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]

OFFICIAL ORGAN OF

THE AMERICAN ROENTGEN RAY SOCIETY

AND THE AMERICAN RADIUM SOCIETY

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VOLUME X NUMBER 11

November, 1923

PUBLISHED MONTHLY BY PAUL B. HOEBER
NEW YORK CITY

FIFTH ANNUAL MEETING EASTERN SECTION AMERICAN ROENTGEN RAY SOCIETY, CHALFONTE-HADDON HALL, ATLANTIC CITY, N. J., JAN. 24-26, 1924.

Entered as second-class matter, March 3, 1916, at the Post Office, New York, N. Y., under the Act of March 3, 1879.

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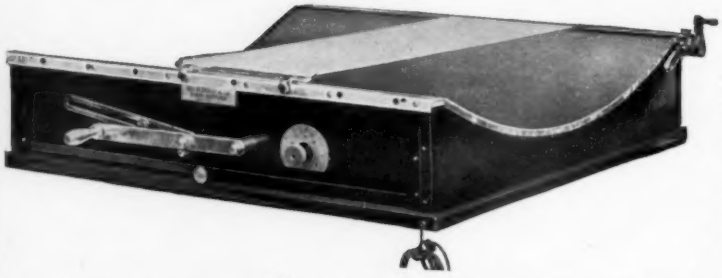

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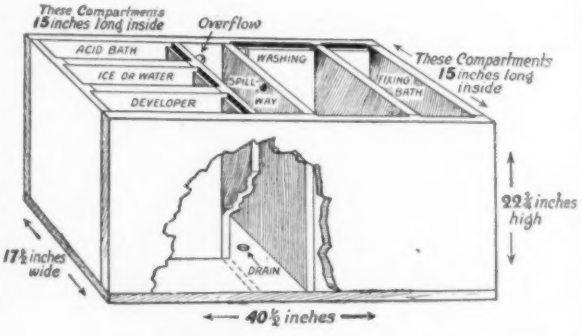

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. X NOVEMBER, 1923 No. 11

THE USE OF RADIUM IN THE TREATMENT OF THE LEUCEMIAS AND HODGKIN'S DISEASE*

BY W. H. B. AIKINS, M.D.

The Radium Institute

TORONTO, CANADA

WHEN we begin the consideration of the leucemias we enter the realm of empiricism. We have excellent clinical evidence of the beneficial influence of radium in these conditions, but our research work has, so far, offered us no good reason for it. Levin has shown that in a frog the lymphocytes are the first to show the effects of radium and *x*-rays. This seems to be true also in man. Other types of leucocytes, as well as the erythrocytes, exhibit a greater resistance, but the pathological cells, such as the myelocytes, seem to be easily destroyed and thus are similar to the cells found in neoplasms. This is another argument for the theory that leucemias are really neoplasms of the blood. It is worthy of note that the lymphocytes in lymphatic leucemia are destroyed "a great deal more rapidly than the identical morphological lymphocytes in conditions of inflammatory leucocytosis" (Levin[1]).

Splenic Leucemia. In no other fatal disease can we do so much with radium as in the treatment of splenic leucemia. One can promise almost with certainty that a remission will follow the first application. Sometimes within twenty-four hours the general condition of the patient improves; for example, he regains his appetite and his sleep. The blood picture is changed for the better in a few days, the white count dropping so quickly on a few occasions, that the application of the radium had to be stopped. Last of all the spleen recedes, generally to the rib margin, seldom farther. This can best be illustrated by the following histories:

CASE 3201. Male, forty-nine years of age, a car inspector. Had been in failing health for a year or more. He was a stout, red-faced man, weighing 190, but reported to his physician because he tired before the end of the day. The enlarged spleen, almost in the pelvis, and the white blood count of 416,000 myelocytes, 67 per cent, made the diagnosis. Radium in flat applicators was given, 2750 mgm. hours in all. In twenty-four hours the abdominal distress which had been present for some months was markedly less, his appetite returned, and he was able to sleep. In two days his white count dropped to 256,000, and in four days his spleen was 2 in. smaller. A week later he returned to work and has been in good health for four months.

CASE 1106. Female, aged thirty-one. Had been losing weight for about a year. In March, 1917, was noticed enlargement of the spleen and the blood count showed leucemia. In July, 1917, she received radium treatment and improved to such an extent that she was able to resume ordinary duties. In December she experienced loss of strength, and was given further treatment in February, 1918.

*Read at the Eighth Annual Meeting of the THE AMERICAN RADIUM SOCIETY, San Francisco, Calif., June 25–26, 1923.

This was repeated in August and November, each treatment restoring a certain amount of her former strength. In March of the following year, also, she received radiation, but after this treatment she did not rally. She gradually sank, and died in July, 1919, two years after treatment with radium had been begun.

CASE 2020. Male. Came to us in June, 1920. He had experienced weakness since the previous December, and enlargement of the spleen was first noticed in May, 1920. When seen in June the spleen extended 2 in. beyond the umbilicus, there was slight epistaxis, and the patient was thinner than normal; the red blood count was 3,904,000 and the white count 333,500. At the end of the first radiation, five days later, the reds had increased to 4,128,000 and the whites were down to 236,000. Radiations were given at varying intervals until February of this year. After each radiation the white count was markedly reduced. When last seen the count was down to 62,000. The disease is still being most satisfactorily held in check.

These cases illustrate the extraordinarily rapid and powerful effect of radium in leucemia. Unfortunately the improvement is not permanent, and within a few months there is a relapse, which, however, yields again to radiation. In order to hold the patient at the maximum of improvement, the spleen has, in certain cases, been excised after treatment with radium. But the relapse comes as certainly, in spite of the operation, so that this surgical measure is not to be recommended.

Our experience with leucemia has been that of several others. Gulland of Edinburgh[2] finds that radium is not suited to the treatment of lymphatic leucemia, but that the most favorable form for this treatment is chronic splenic leucemia. He had been treating the latter condition with *x*-rays, but, as he was not getting satisfactory results, he tried the effect of radium. The results were not more permanent, but were more certain and rapid, and he considers that patients improve more in general condition and in recovering from their anemia. Bonta[3] reports the results of radiation in the chronic types of leucemia in which he obtains marked improvement in the general condition and rapid reduction of the spleen or enlarged lymph-nodes. These results also are corroborated by Stern,[4] who states that of the leucemic diseases the most satisfactory response to radium is found in chronic myelogenous leucemia.

The method of application in this condition is of the utmost importance. It has been shown experimentally that the larger the square surface of the entry of radium or *x*-rays into the organism, the more severe is the general effect upon the blood. In the leucemias we desire this destructive action, so we use large, flat applicators in preference to tubes. These are backed by metal so that the total amount of rays entering the body is much more than would be charted in milligram hours. Each of these plaques is well screened and applied over the spleen long enough in each position to produce an erythema. By marking off the spleen area into squares of the size of the applicator, we are able to give from 2,500 to 4,000 mgm. hours at each seance. The intervals of treatment will depend upon the condition of the patient.

In a few cases the constitutional symptoms, such as nausea, vomiting and diarrhea, were pronounced after these large doses, but they passed off in a few days. The urgency of treatment is uppermost and these minor details may be disregarded.

Since we have adopted this method of treatment we have had the satisfaction of giving all of these doomed patients some respite from their worst symptoms. The "life-history" of the disease is so variable that it is mere conjecture to say that their days have been prolonged. Some of these patients have a chronic form of the malady, and have lived five years or more without any treatment. But one cannot resist the impression that life was made comfortable and was probably prolonged by radium treatment.

Lymphatic Leucemia. When we come to consider lymphatic leucemia and those conditions which seem to be a mixture of the two leucemias we are not able to hold out the same prospects. It is true that many cases of lymphatic leucemia are improved by radium, but the enlarged glands are usually so scattered over the body that it is difficult to apply a suffi-

cient dose of the gamma rays, and so we cannot promise the same remission as in splenic leucemia. But the white count will be markedly reduced, and sometimes the lymphatic glands return to normal size. As in splenic leucemia the general condition is improved for a time, and one feels that it has been worth while.

Gulland[2] reports satisfactory results in the radium treatment of Banti's disease. The spleen became smaller, and the patients improved so much that splenectomy was not required.

Hodgkin's Disease. This may be successfully treated with radium. There are no characteristic changes in the blood picture, the only guides to improvement being the size of the enlarged glands and the general condition of the patient.

According to Ewing[5] the initial symptom in Hodgkin's disease is an enlargement of a chain of lymph-nodes, cervical (50 per cent), axillary, or inguinal, and the continuous or irregular extension to other chains. He states that a splenic tumor develops in 60 to 70 per cent of the cases, and that there is frequently enlargement of the liver. With such generalization of the disease, fever, night sweats, anemia, and cachexia appear.

The diagnosis of Hodgkin's disease is, however, difficult. It is no easy matter to distinguish between sarcoma and Hodgkin's disease. The interrelation between the two has been discussed by a number of writers. Mueller[6] reports 2 very interesting cases, one of which was ascertained by biopsy to be Hodgkin's disease, but on autopsy was found microscopically to have been changed into round-cell sarcoma. The second case was one which presented, clinically, symptoms of a mediastinal tumor of moderate size without the usual multiple enlargement of the lymph-nodes of the neck, axillae and groins, except for a single moderately swollen node in the left side of the neck. Radiation had no effect on the tumors, and biopsy left the diagnosis between round-cell sarcoma and lymphogranuloma, autopsy confirming the latter diagnosis. From these two cases Mueller concluded that lymphogranuloma (Hodgkin's disease) and round-cell sarcoma of the lymph-nodes are only different expressions of the same process. This view is supported by similar reports from Yamasaki, Karsner and Welch.

Burnam[7] points out the close resemblance between lymphosarcoma and Hodgkin's disease. Of cases which were definitely lymphosarcoma, 2 had remained well with no recurrence for more than five years, and 4 had not recurred after three years; of cases which were definitely Hodgkin's disease, 1 had been well for four years, and 2 had shown no recurrence after three years. In concluding his paper he states that, while there is no objection to complete surgical removal of a localized group of glands in these diseases, if such procedure is followed by radiation, his results lead him to believe that surgery is quite unnecessary.

The following histories of cases of Hodgkin's disease which I have treated give ample evidence of the value of radium in this condition:

Case 2453. Male, aged thirty-three. First noticed enlargement under the left jaw in 1917. The mass had not increased much in size in May, 1921. At that time there was a glandular development about the size of a small hen's egg below the left maxilla, and the patient had been advised several times to have it removed surgically. A second gland about the size of a hazel-nut was attached beneath the chin close to the middle line. There was also a chain of enlarged glands just above the sternoclavicular articulation about the size of a hazel-nut. No involvement in the axillae could be detected, and the spleen was normal in size. Throughout the course of treatment marked decrease in the size of the abnormal glands was noted. In April, 1923, his condition was excellent. We considered him a sufficiently good risk to take out an insurance policy at a slightly increased premium. However, it is interesting to note that when the policy was issued the premium attached was a normal one. There still remains a slight enlargement of the chain of glands on the left side of the neck. No glands are palpable in the axillae or groins, and the spleen is normal in size and position.

Case 2057. Male, aged thirty-four. Reported to me for treatment on July 8,

1920. He had an enlargement about the size of a small egg on the left side of the neck. It had been first noted two years previously. He had tried "blistering" with no beneficial effect. The cervical glands also were involved. He was given deep radium exposures every month for five months, after which time the size of the enlarged glands had diminished markedly and there was no evident involvement above the clavicle. His treatment was suspended. He returned seven months later with small glandular involvement over the left side of the neck. This was given a heavy radiation, the last exposure being in August, 1921. He did not return until April of this year, having remained free of symptoms during that time. There is now a development above the right clavicle, which we are treating. Radium has been most beneficial in holding the disease in check.

CASE 2303. Male, aged thirty-six. Came to me in December, 1920. Four years before this date he had been operated on and glandular tissue from the cervical region had been removed. About one year later recurrence had commenced, first at the angle of the jaw, and later above the clavicle. Enlarged glands were present in the axilla when first examined. There was no enlargement of the spleen. His general health was fair. Radium treatment was given at six-week intervals, and has been continued. He has shown gradual but definite improvement, and might now be considered clinically cured. It is essential, of course, that he keep in close touch with his physician so that any recurrence may be treated immediately.

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DISCUSSION

DR. H. H. BOWING, Rochester, Minn. This is a very interesting paper, in that the primary result in practically all patients in the group described is rapid. In some instances the amount of local reduction in the tumor is astonishing. The leucemias, Hodgkin's disease, and lymphosarcoma can be classed under one head as blood dyscrasias. If I understood Dr. Aikins, he uses the flat applicator to the point of producing erythema. In some of the early cases treated in the Mayo Clinic, as reported by Dr. Giffin, in 1917, the erythema was believed to be necessary. It was first attributed to the adhesive plaster used. Then an applicator was devised, including a wood plaque with holes to fit the radium tubes and a lead plaque, 2 mm. thick; this was fastened to a leather piece or belt. It produced a first-degree erythema in most patients, and a second-degree in a few. The healing in all cases was usually prompt and in many the telangiectasia appeared, with the ordinary skin changes in an area the size of the applicator. The belt was soon discarded since the distance it furnished was not sufficient. Our present applicator contains a 50-mgm. universal tube of radium, silver walls 0.5 mm. thick, filtered through 2 mm. of lead and maintained at 2.5 cm. distance, the time of application varying from three to eight hours to each area. The same purpose is accomplished without injury to the skin. If the general condition of the patient is good and the history long standing, the 50-mgm. tube is applied and worn for twenty-four hours. If the spleen is large, the skin surfaces overlying four areas are given six hours each. If it is small, eight hours each are given to three areas. If there is marked weakness and secondary anemia with the ordinary blood changes with a high leucocyte count, applications are made more cautiously, the 50 mg. tube, screened as mentioned, being worn for only twelve hours instead of twenty-four. We usually see some reduction in the leucocyte count and some improvement in the condition following the second or third treatment. As long as the leucocyte count goes down and the other blood factors remain as at the time of the first treatment, we continue until three or four have been given. When the erythrocyte count and hemoglobin decrease, the treatment is stopped immediately for fear of increasing the anemia. The interval is usually a week, and at the end of five days a blood count is made to determine whether radium shall be applied again. If delayed, it is usually a month or six weeks.

In cases of myelogenous leucemia patients are supported with roentgen treatment over the long bones, with the hope of securing benefit by further reduction in the myelocytes circulating in the blood.

In lymphatic leucemia with the multiple enlarged glands, it is our rule to distribute the radium, usually employing eight areas, giving three hours for each area; two in the right and left cervical areas, one each in the axillary, one each in the inguinal spaces. With this technique we have seen no skin reactions, and the patients improve. It is usually an index of a favorable change in the blood. As long as patients report that they are feeling better, resting more, their appetite returning, and so on, it is safe to continue the treatment until four have been given, with a subsequent rest of from six to eight weeks. As a group, these patients are very grateful; the initial response is satisfactory and in some quite enduring.

Dr. Laurence Taussig, San Francisco, Calif. From the dermatologists' viewpoint Dr. Bowing's point is well taken. We should avoid causing reaction on account of the possibility of subsequent atrophy and telangiectasia. It makes no cosmetic difference over the spleen but it increases the sensibility of the skin over the area treated and is likely to hinder one in the further treatment of a case.

Dr. Grace L. Homman, LaPorte, Ind. I had a case that ran over 900,000 lymphocytes per cubic millimeter. I do not remember the exact count. Cases have been reported with counts over 1,000,000.

I should like to ask Dr. Bowing why he uses 2 mm. of lead in his screen. My impression is that all one needs is the one-inch distance. The beta rays penetrate only two or three millimeters of tissue and therefore the lead screen seems to me unnecessary.

Dr. Edwin C. Ernst, St. Louis, Mo. My experience in the radiation of these conditions has been largely limited to the use of the *x*-ray rather than radium. Those cases in which radium was employed exclusively did not react satisfactorily; the dosages employed were no doubt too severe. Therefore, our experience with radium has been too limited to be of value in this discussion.

However, 14 or 15 cases of myelogenous leucemia, in which there had been a return of the splenic enlargements, together with a return of the original blood pictures, a type of cases very unfavorable, after having received a series of *x*-ray treatments, did respond to the second series of radiations. We did not attempt to force the treatments, employing extremely mild dosages of *x*-rays. The amount of radiation at times did not seem sufficient to produce any cellular changes. Nevertheless, we believe that the treatment of these conditions warrants mild but repeated exposures. The above series of cases had a return of symptoms. This was due entirely to the fact that they failed to appear for further treatment, contrary to our instructions to report regularly at certain prescribed intervals.

All of the above patients are in comparatively good health, symptom-free, for periods ranging from two to five years. Those patients in whom more intensive radiations were employed, failed to respond in an equally favorable manner. The technique employed ranged from 135,000 to 140,000 volts, sphere-gap measurements, employing a filtration of 4 mm. of aluminum at a focal skin distance of from 10 to 12 in. The time factor was frequently as low as 15 ma. minutes over each area. This amount of radiation was employed directly over the splenic area at long intervals, the long bones receiving the more intensive radiation. The intervals between treatments were gradually increased. Most important of all, we did not attempt to reduce the white cell count too rapidly.

Dr. Sanford Withers, Denver, Colo. Has Dr. Aikins ever estimated the greatest possible number of lymphocytes that might be in a cubic millimeter? I had a case of lymphatic leucemia that came in with a count of 860,000 per cubic millimeter. According to my calculations a cubic millimeter of blood should not be able to hold more than 1,200,000 and I should like to hear if anyone else has had a case of lymphatic leucemia with such a high count.

Dr. William E. Montgomery, Kansas City, Mo. I wish to report a case of myelogenous type treated by the old method. The patient is now living and has had no treatment for eight years. The last blood count showed 20,000 white cells. He still has a lemon color and is not very robust but is able to attend to his business. All the other cases I have treated are dead. I thought this case was a little out of the ordinary.

Dr. R. E. Loucks, Detroit, Mich. I have been interested in this condition for some time. It was my misfortune to treat a medical friend who had a myelogenous leucemia. The first intimation was a hemorrhage in his eye and we found splenomyelogenous leucemia. He was very much alarmed. He had some experience with the *x*-ray and did not have much faith in it. He came into our service and we treated him for five or six years. He improved greatly and was quite well during that time, continuing his practice. He did not exactly follow the rules we laid down, but ate

what he wanted and drank what he could get, so it was hard to keep him under control, but we made him very comfortable for five or six years. Then the spleen was so large that radium did not seem to have much influence on it, so I turned him over to Dr. Stevens and we rayed the long bones for about a year, but did not get much reduction in the size of the spleen or white count. He lived for about six years and died of a terminal pneumonia.

I have another case that has been under observation for four or five years. After his first treatment he was very well for about a year. One night he had a vomiting spell with terrific hemorrhage. He became greatly exsanguinated and we had to do a transfusion immediately. We applied radium later and he picked up quickly. We treated him again two months ago but now his spleen fills the entire abdominal cavity and is becoming hard. His white blood count is something like 600,000 and we do not expect to get much result from treatment.

I have never seen much benefit from the treatment of the long bones with *x*-rays. It has been advocated for some years and I think all of us have tried it, but I have never had as good results from the *x*-rays as from radium. I have used 200 mgm. over the different areas and have given them as much as twenty hours, distributed over five different areas. It does give the patients a lease on life and probably we can do as much for them with radium as with anything else.

Dr. H. H. Bowing, Rochester, Minn. Answering Dr. Homman's query as to the 2 mm. of lead, I have often questioned its use in this formula, but I know that wherever a number of areas confined to a small space are treated, the use of lead is essential, to avoid an erythema. It requires so little radium and time of application to bring about the desired result, that I have never seriously questioned removing the lead from the applicator.

Concerning the blood count of 1,000,000 or more, I do not recall a case in which the leucocytes reached a million. The largest count I can remember was 700,000 and the response was gradual, although the reduction was greater each week and more rapid.

Concerning splenectomy as a procedure in the management of these cases, I do not care to make any statements, since I am not familiar with the studies now in preparation at the clinic. It has been my privilege to treat splenectomized patients. The hepatic area is exposed to small quantities of radium. The reduction in the blood count occurs, but the liver does not reduce in size. A case has been reported in the literature in which the spleen was removed, and the splenic area treated, with good results.

Dr. Henry Schmitz, Chicago, Ill. In a series conducted with Drs. Ochsner and Percy we used about 100 mgm. radium element over the spleen for fifty hours divided over six fields at a distance of 3 cm. Within fourteen days the spleen was reduced to normal size and the white blood count was usually from 15,000 to 30,000. In some cases the improvement would last from three to six months, when reapplications of radium had to be made. However, with each subsequent course of radiation the patient seemed to have acquired a greater resistance to the rays and did not respond promptly. The *x*-rays, apparently, were not as efficacious as gamma rays. Radiation of the bone-marrow, also, was not followed by better results. Persistence of the spleen to renewed enlargements usually was an indication for splenectomy.

We may say that radiations in splenomyelogenic leucemias retarded the fatal outcome from two to four years.

Dr. Aikins (concluding discussion). In treating these cases with radium we have always considered the leucemia so grave that an erythema is of minor importance. However, we avoid this whenever possible. We have found it necessary to give a certain amount of radiation before any improvement can be expected in the condition of the patient. In severe cases as much as 2,000 to 4,000 mgm. hours is required. In reply to Dr. Withers' question I may say that I have not estimated the possible lymphocyte count per cubic millimeter but the highest count we have had was 750,000 per c.mm.

THE TECHNIQUE OF RADIATION THERAPY OF ESOPHAGEAL CARCINOMA*

BY JAMES T. CASE, M.D., F.A.C.S.

BATTLE CREEK, MICHIGAN

IN few situations does a malignant lesion present greater difficulties in the technique of radiation application and dosage, or less probability of completely destroying the neoplastic tissue than in carcinoma of the esophagus. Unfortunately, the attention of the patient is not drawn to his trouble until dysphagia appears; and this is therefore the earliest clinical symptom, usually the one which brings the patient to the physician. Yet esophageal carcinoma furnishes a large proportion of erroneous diagnosis or failures to diagnose, owing to the absence of the symptom of dysphagia. This was shown in the statistics published some years ago by Richard Cabot, after reviewing the incorrect diagnoses in a large series of cases at the Massachusetts General Hospital.

Roentgenologically, the earliest sign of esophageal carcinoma may be due to the obstruction of constant grade one would expect from the organic stenosis attending the malignant lesion. The writer has found many cases of esophageal carcinoma where the first signs of obstruction were apparent long before there existed any actual narrowing of the esophageal lumen, the hindrance being due to a spasm set up at the level of the early malignant lesion, or just above it, a considerable time before the infiltrating process had brought about actual stenosis. This is especially true of those cases of carcinoma of the lesser curvature high up in the stomach involving the cardiac orifice. It often happens that these obstructions are at first considered spastic because the administration of antispasmodics temporarily relieves the dysphagia. Occasionally an extra-esophageal malignant mass will be accompanied by a spasmodic obstruction in the esophagus. The writer has in mind particularly one case in which the esophageal obstruction was by post-mortem shown to be due to a carcinoma of the lesser curvature of the stomach, with extensive infiltration of the glands about the cardiac orifice and some infiltration of the cardia; yet the site of the obstruction in the esophagus, as determined both by sounds and by the roentgen studies, was two or three inches higher than the infiltrated area, and it had all the earmarks of a spastic hindrance. We therefore make routine use of antispasmodic medication, both in the study and the treatment of esophageal lesions thought to be malignant. One of the most important technical problems to be overcome in radium treatment of esophageal cancer is the delivery of an adequate dose of homogenous radiation into the depths of the tissues. The investigations of Friedrich, supplemented and corrected by Schmitz working in Friedrich's laboratory, show how rapidly the efficiency of radiation from a radium capsule diminishes at a short distance from the applicator; so that unless one does considerable damage through overdosage to the tissues actually in contact with the radium applicator, he will not deliver an efficient dose into the depths of the lesion, say only two centimeters beneath the mucous membrane, and certainly nothing like an efficient dosage along the normal lines of extension. If the lumen of the stricture suffered sufficient dilation to permit from 8 to 15 mm. of rubber tissue wrapped around the radium in its usual metal container, the added distance from radiant source to mucosa would greatly improve the depth dosage, though much prolonging the time of application. Yet, one hesitates to dilate a malignant stricture at all, and in the light of our present knowledge he surely will not do so any more than is absolutely required for introducing some form of radium applicator, fearing that the instrumentation may do more harm than the radiation does good. The radiologist is thus by circumstances limited to an unequally distributed, non-homogeneous radiation, if he depends upon radium alone; therefore the natural tendency to supplement the radium application by external applications of radium by packs applied at

*Read at the Eighth Annual Meeting of THE AMERICAN RADIUM SOCIETY, San Francisco, Calif., June 25–26, 1923.

some distance from the skin, or by deep roentgen irradiation, or by both.

Another serious problem is an accurate visualization of the lesion, as interpreted from the *x*-ray and clinical findings. Some have recommended the routine study of these patients by means of the esophagoscope, but such instrumentation is extremely distressing to some patients and, for various reasons, quite impossible in others.

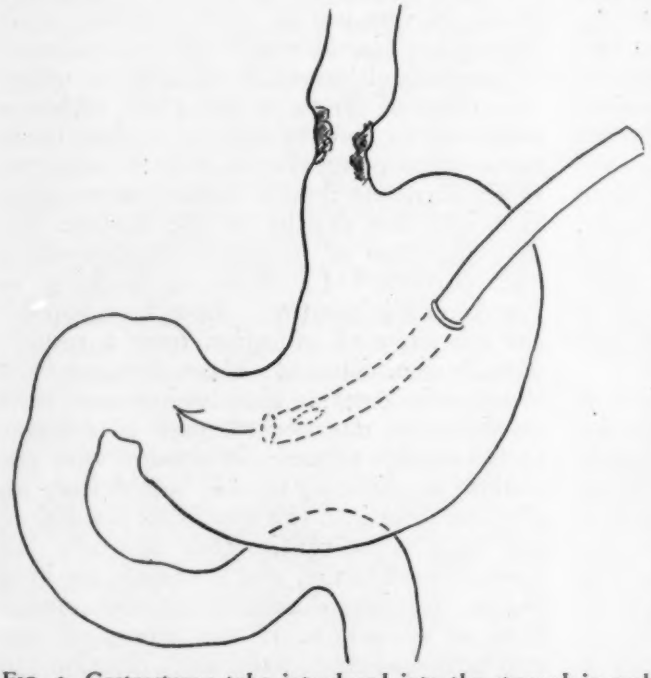


FIG. 1. Gastrostomy tube introduced into the stomach in such direction that a duodenal sound passed through this tube will be directed into the pylorus.

It is not easy to make an accurate map of the infiltration or ulceration in any given case, and yet an error of estimation amounting to only a centimeter or so makes a great difference in the result. The above considerations emphasize the obvious need of the greatest possible accuracy in the mental picture formed of the lesion under attack, the need of abundant filtration and a maximum of distance from radiant source to lesion, none of which ideals are capable of satisfactory realization, at least in the present state of our attainments.

RADIUM METHODS

Various methods have been devised and employed by all of us in the attempt accurately and efficiently to place the radium.

1. *Radium-bearing Sound Guided by a Thread.* By the well-known technique, a thread several feet in length is employed. Eight or ten inches of this stout but very fine thread is enclosed in an ordinary 5-gr. capsule and swallowed. Careful "feeding" of the thread aided by hypodermic injection of atropine to the point of securing marked dryness in the throat, plus the frequent sipping of small amounts of warm water, will, in most cases, carry the thread through the stricture and on along the digestive tube distally until traction on the thread reveals the stout resistance offered to attempts at withdrawal.

In other cases success has followed the use of atropine to the point of marked dryness of the mouth followed by a little paraffin oil. The thread once in place, it is a relatively simple matter to give the patient a swallow of a barium mixture, not too opaque, to permit accurate screen observations of the site of the lesion, and to thread over the silken guide the radium-bearing sound, the construction of which will be taken up further on. When through with the silk thread, it is withdrawn by mouth as far as possible and cut off, the remainder passing on into the intestine. Not the least difficult of the steps of this procedure is the *maintenance* of the radium in proper position, once it has been placed under the guidance of the fluoroscope. The writer prefers to put a mattress and other comforts on a horizontal fluoroscope and leave the patient lying quietly in the position assumed during the sounding. The distal end of the radiferous sound is attached to the cheek by adhesive plaster, first bending the sound over the teeth in such a way as to mark securely the proper location. It is well to alter the position of the sound, deliberately attempting to place it a little too far at the first and a little short of the lesion at the third change.

2. *The Radiferous Sound Canalizing the Stricture under Fluoroscopic Guidance.* This method, already long before devised and practiced by various radiologists, was reviewed and improved by Mills at the St. Louis meeting of this Association. Mills deserves special recognition for the very ingenious modifications of the sound, permitting the terminal radiferous end to be bent in only one of four directions, while the remainder of the sound is susceptible of any sort of angulation. This small but very important addition to the instrument permits canalization under screen control of practically every organic stricture to be met; yet occasionally one sees a case in which the method is impracticable. Sometimes the stricture is too tight for passage; again sometimes the patient proves to be unable to tolerate the esophageal and pharyngeal manipulations; the instrumentation of the lesion, with more or less traumatism, as in the thread method, is prejudicial to success; and finally many patients experience the greatest distress in maintaining the sound so long in the esophagus because of the hurt to the pharynx and mouth.

3. *Gastrostomy, Plus Thread Method.* A gastrostomy may be performed, under local infiltration anesthesia, the technique being such that an efficient valve-like gastrostomy opening results. It is the writer's custom to perform this operation in such a way that the gastrostomy tube points toward the pylorus, care being taken to use a rather large tube, sufficient to permit the passage through it of an ordinary duodenal tube without its metal tip. Almost immediately after the operation, if not at once, a duodenal tube is passed through the gastrostomy tube, on through the pylorus well into the duodenum, the position being verified by *x*-ray observation. It is not required to move the patient to the fluoroscopic room; a bedside *x*-ray equipment is quickly moved to the patient's room, and little trouble is caused by slipping a film beneath the sick one, to make the necessary *x*-ray exposure. Duodenal feeding is begun at once. The operation successfully performed, a thread is prepared, as in the first method described, and one end of it, in a capsule, swallowed. A fine thread may be employed, a stouter one being drawn down, once the end of the finer one has been recovered from the stomach through the gastrostomy opening. Formerly the writer used an ordinary shoe-button hook or a strabismus hook, or Kellogg's ligament hook, to fish up the thread, but a simpler way recently presented itself. With an ordinary washout 3–4 oz. syringe, fill the stomach with water; then, leaving the syringe attached to the tube, withdraw the tube, syringe and all. The thread readily floats out through the opening with the escaping fluid. By gentle traction the fine thread is pulled down, drawing with it a much stouter guide thread. When the stout thread is in place, from mouth to gastrostomy opening, the lower end of the thread is passed through the gastrostomy tube, which is again introduced into the stomach. Under the traction required to pull down the radium applicator attached to the upper end of the thread, damage may be done to the lining of the stomach by the "sawing" of the thread unless this tube be in place. The inner end of the tube may even be pulled up into the

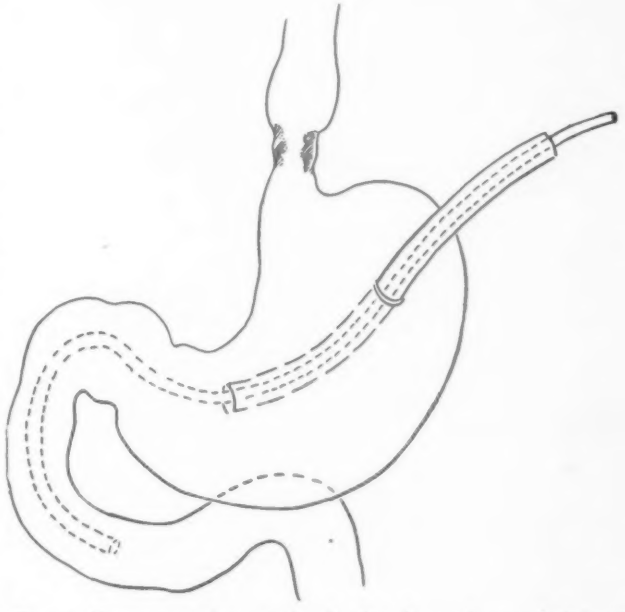


FIG. 2. Representation of the duodenal sound passed through the gastrostomy tube and on into the duodenum for duodenal feeding.

lower end of the esophagus, which is additional insurance against "sawing" the mucosa. It is important to maintain a thread attachment to the radiferous capsules through the mouth, for one may need to alter the position either upward or

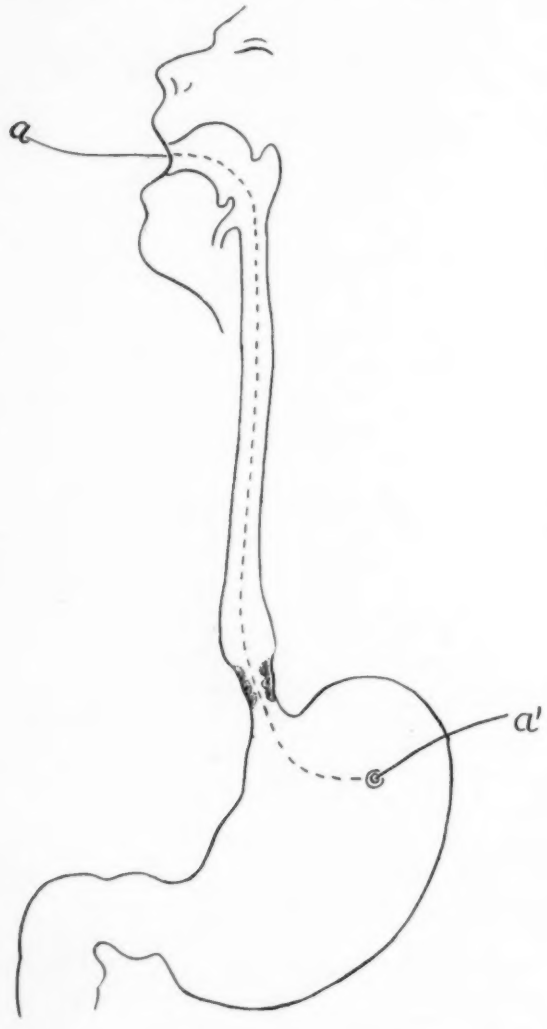


FIG. 3. Thread $a - a'$ passed from the mouth through the esophagus, past the malignant stricture, and out through the gastrostomy opening.

downward. On one occasion the extra silk thread served for removal of the capsule when the other end of the thread broke. Among the advantages of this thread method when combined with gastrostomy may be mentioned:

(*a*) The ability to begin abundant feeding at once and to maintain good nutrition through the gastrostomy opening.

(*b*) The greatly lessened discomfort to the patient during the radium treatments.

(*c*) Ability to place the radium more accurately. It is needless to add that all these manipulations and collocations of the radiferous capsule are done under careful and repeated screen control.

As to the added comfort to the patient during the application, when only a thread passes through the mouth and pharynx instead of the very uncomfortable sound, it is possible to construct a sound in such form that the staff can be removed after the placing of the capsule, which is removed later by means of a thread left attached to it. However, the writer feels that in view of the ultimate bad prognosis and the necessity of improving the patient's nutrition immediately and maintaining it, the gastrostomy is a desirable addition to the technique.

Of course, in this gastrostomy-thread method it is possible to pull up the radiferous capsule from below through the opening in the stomach; but this traumatizes the gastrostomy opening, and much distress is caused by the traction on the thread in the mouth and pharynx.

4. *Esophagoscopic Implantation of Radium Needles or "Seeds."* This is a method in which the writer has had little experience, but one which is highly recommended by several well-known men (Yankauer, Guisez, etc.). The latter recently reported several cases in which apparent cure has lasted nearly three years, where radiferous needles have been placed in and about the esophagus lesion under the direct control furnished by esophagoscopy. In the experience of the writer and his colleague there are many objections to esophagoscopy in these patients, who are weakened, old, and often in such a state of distress that esophagoscopy cannot be tolerated. Even when accomplished, the implantation of needles is thoroughly done only around the upper pole of the stricture, and there is the ever-present danger of perforation, either immediate or after a few days. One case has been reported where death occurred from a small perforation into the aorta. In the employment of this technique "seeds" of radium emanation are preferable to any other form of radium applicator.

This method has the obviously great advantage of permitting accurate vision of the lesion and the progress of the treatment. Undoubtedly the method will appeal to the men who have had special training in esophagoscopy.

PURELY ROENTGEN METHOD

Under modern roentgenotherapeutic voltage, long focus-skin distance, large fields and heavy filtration, the administration of a highly efficient dosage of roentgen rays to the neighborhood of the esophageal lesion is feasible. The writer employs four fields, as a rule centering the radiation as nearly as possible upon the carefully mapped out objective. The dosage upon the skin is variable, the intention being to deliver to the lesion considerably more than a full erythema dose (120–130 per cent E. S. D.). Our effort has been to deliver this dose within about four days' time; but the observations of Regaud and his colleagues give good ground for the belief that the same dose given in from ten to twelve days' time is more efficient, while being much less distressing to the already weakened, undernourished patient. Surely the roentgen method has the advantage of avoiding all intraesophageal manipulation. This, according to Simone Labord, is a reason for preferring the roentgen method to the exclusion of intraesophageal radium, for fear that radium treatment of esophageal cancer sometimes actually shortens the patient's existence.

COMBINATION ROENTGEN AND RADIUM METHOD

A combination of the external application of roentgen radiation with the intraesophageal application of radium appears to the writer to be the ideal method. This belief is borne out by our clinical results which show greatest prolongation of life, although our results are no better than those reported by Mills a year ago. We have performed gastrostomy on three-quarters of our patients, and have given them by this means alone a marked degree of palliation.

COMMENT

In our own work we prefer the method of gastrostomy under local anesthetic, followed in ten days by the placing of the thread, and three or four days later by the first application of radium. A series of roentgen applications through four fields is then given, if it has not already preceded the operation. On about the twentieth and twenty-fifth days further radium is applied, and a program of watchful waiting instituted. In the preparation of

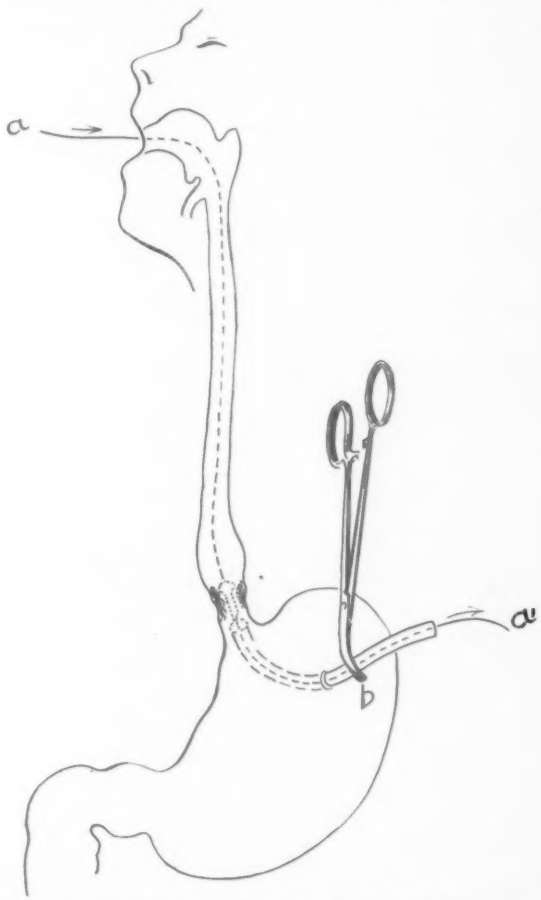


FIG. 4. This thread is then passed through the gastrostomy tube, which is reintroduced into the opening into the stomach. Traction upon the thread $a - a'$ in the direction of a' pulls the inner end of the gastrostomy tube up to the inferior border of the stricture thus preventing sawing of the thread upon the soft tissues at the cardia. The radiferous capsule is then drawn down the esophagus into the stricture under *x*-ray guidance and the taut thread held in position by the forceps "b" clamped on the gastrostomy tube close to the skin.

the radium applicator, whether for use by the sound or by the thread and gastrostomy method, it is our custom to use two, and at times three, capsules, placed end to end, a 100 mgm. in the middle, and a 50 mgm.

capsule on either end. The whole is contained in the usual 1 mm. of brass filter and wrapped with plastic rubber of the thickness estimated feasible in the given case, using the maximum amount of wrapping. Near the upper end of the preparation, a cuff of rubber is wrapped in such a way as to form a guard against the slipping of the preparation entirely below the stricture. Of course, in some cases it is impossible to canalize the narrowed lumen

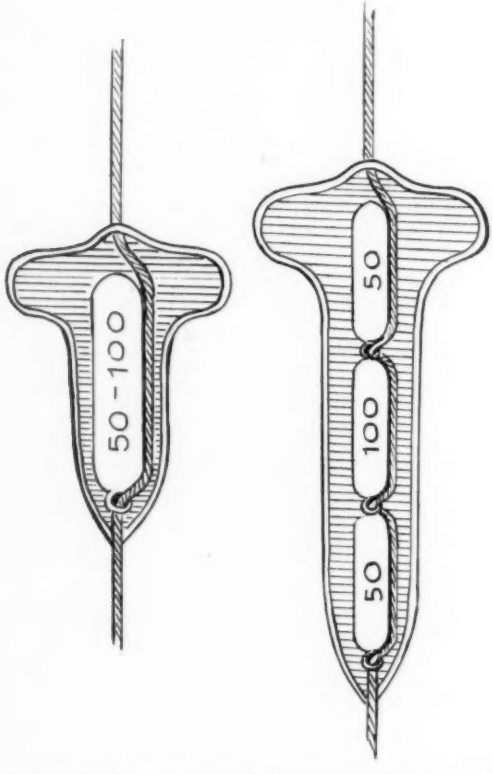


FIG. 5. Details of construction of radiferous capsule. The radium capsule threaded is wrapped with elastic rubber in such thickness and shape as the indications of the case permit. The upper end of the capsule is widened out so as to form a shoulder. One can feel impaction of this shoulder against the upper end of the stricture and thus know when to stop pulling.

with even the ordinary applicator in its brass cover, to say nothing of additional rubber; in such cases we content ourselves with the silver filter for the first time, usually finding that it is possible, after the lapse of a few days, to use the more bulky applicator.

Renewed roentgen applications and radium treatments are given when circumstances warrant, but it is our intention and hope to give all the radiation necessary during the first attack. We hope so to perfect our calculations and our technique that this may be realized; but to date we have found it necessary to continue treatment into the second or third series.

The method preferred by the writer includes, then, the following:

1. Careful *x*-ray survey of the lesion, realizing how much of the deformity in the esophageal lumen may be due to associated spasticity.
2. Preliminary deep roentgen treatment.
3. Gastrostomy, followed at once by duodenal feeding.
4. Ten to fourteen days later placing of thread from mouth, through stricture, and out of gastrostomy opening.
5. Intraesophageal radium treatment by aid of this thread under careful fluoroscopic screen control, endeavoring to administer all necessary radiation during first attack.
6. Careful periodical review of case from month to month with repetition of radiation therapy as needed.

DISCUSSION

DR. HENRY SCHMITZ, Chicago, Ill. The treatment of cancer of the esophagus has been anything but encouraging in the hands of most of us. The reasons for this are: First, the trauma which is usually caused by the insertion of the radium dose, and second, the impossibility of applying the correct radium dose. I feel that we can congratulate Dr. Case upon the method he has demonstrated. It appeals to me as the most rational of which I have heard. The danger in the use of radium in the esophagus is the local destruction caused by the radium. The trauma results in increased difficulty in swallowing, interferes with nutrition and decreases the strength of the patient alarmingly. I have not seen any case in which we have had even temporarily good results. The patients have been worse off after the application of radium than before.

The method advised by Dr. Case insures proper feeding and enables one to place the radium capsule correctly and for a length of time necessary to insure results. Finally, the added radiation of the *x*-ray enhances the efficacy of the treatment.

DR. SANFORD WITHERS, Denver, Colo. I am heartily in accord with the use of a gastros-

tomy to relieve the continual massage of the esophagus by the passage of each bolus of food.

For placing the radium in such cases I mold a sort of shoulder-like disc of wax on the capsule or wire guide to prevent the radium from going below the stricture. The radium capsule and hard wax disc are covered with paraffin to give a smooth nonconductive coat.

Dr. H. H. Bowing, Rochester, Minn. I do not know whether our results are any better than those of Dr. Case, but certainly they are better than those of Dr. Schmitz. These patients get a wonderful amount of relief from the dilatation alone. I recall one patient who returned to his work and lived for three years. His only symptom, when last seen, was a chronic cough, and the *x*-ray examination of the chest showed multiple metastatic areas. If we had given him irradiation we would have credited this improvement to the treatment. We can probably give the majority a longer lease on life with treatment than without it.

We use the string method described by Dr. Case. With the string in position the sound may be passed along its course with the least chance of injury to the diseased esophagus. We always begin with a small olive, and increase the size until we get one that enters with some difficulty; then we know we have an olive that will help to hold the radium applicator in position. The applicator itself is about 7.5 cm. long and it will hold two tubes of radium.

The upper end of the applicator is fitted with a large olive that will not go beyond the obstruction. The smaller olive will just go through the tumor and will not be regurgitated; the large olive is fitted with a whalebone bougie. The latter has previously been marked in order that the depth of the lesion from the incisor teeth is known. When the applicator is in position we can withdraw the whalebone bougie and to this we have attached several strands of strong fish line. We are absolutely sure the patient will not swallow the applicator and that it can be withdrawn. The patient can tolerate the applicator without any signs of difficulty, but I have found that there is a great amount of trouble with excessive salivary secretion; this is distressing and can be controlled with morphin and atropin.

We are not satisfied with our results, but I know we can apply the radium in the esophagus with some assurance that it will stay put, and the patient can wear the applicator for twelve hours or longer without much discomfort.

Dr. W. H. B. Aikins, Toronto, Ont. The appliance described in detail by Dr. Case may, I trust, result in greatly modifying the hitherto unfavorable results so far obtained in the treatment of carcinoma of the esophagus; and we look forward to hearing from him to that effect.

Prof. Lars Edling, Lund, Sweden. I have treated a small number of cases of carcinoma of the esophagus, I think not more than 10. In those I had a good result in 3 cases; in 2 I have observed a very good result; 2 cases I have observed after about two years in each case. One case was treated four years ago and that patient lived for at least two years afterward. I have heard that she has since died, but I do not know just how. The other case was treated three years ago and I saw that patient last March, when she was quite well. The third patient was treated early this year and is still alive, feeling well and can eat. The tumor was in the upper third of the esophagus and that, of course, makes the treatment very much easier, especially in regard to combining the *x*-ray treatment which has been used in all cases.

I have used for the purpose of applying the radium a common sound made of two catheters placed together so as to have the length required. I have a joint in the upper end so that the radium tube may be placed within the capsule. The radium tube is of lead with 1 mm. of gold. The capsule is placed under control of the *x*-ray and attached to the side of the face by a stitch and at the border of the teeth also by a stitch. There has been no special difficulty in holding the radium in place in these cases, but of course the patient is much distressed by the saliva. Because of that I have always used atropin, with very good results. The dosage used has been 45 mgm. and the time of treatment over twenty hours. In one or two instances the patient could not hold it, and then I repeated the dosage.

Dr. Henry J. Ullmann, Santa Barbara, Calif. I would like to take advantage of this opportunity to show a way of improvising when one has not the apparatus Dr. Bowing spoke of. A patient was presented who had refused gastrostomy. The size of the olive tip that would go the length of the stricture had been determined by means of the *x*-ray. The next larger olive was put on the rod and the lower end of a catheter containing the radium capsule was slipped over it. The thread was run through the tip of the catheter and the outfit inserted as far as it would go. The olive stopped at the stricture and the catheter end with the radium then lay within the stricture, held by the olive above. This might be found useful if a more efficient type of apparatus was not available.

Dr. Henry P. Beirne, Quincy, Ill. If you get the linen thread the harness makers use you can hold a mule with it. You can wax

it down to any size you wish and never lose your radium.

As a temporary dilator I have had patients swallow an ordinary shoe button, taking it with the food and letting it make its own dilation. Two or three days later it can be pulled out and no harm done. This is a home-made affair, of course, but in one case the patient was able to eat more food and the clinical results were better.

Dr. Case (closing discussion). The gastrostomy, I realize, is objectionable; but under local anesthesia there should be no fear as regards life, and I think it is a valuable procedure. The patient's nourishment is then assured. We have a means of feeding him that is available in spite of anything which may happen to the esophagus. The point one speaker brought out about diverting the food from the traumatized area is very important.

In employing radium, it is highly necessary to take account of the amount of rubber tissue filtration placed outside the brass capsule. We know that the intensity of radiation diminishes inversely as the square of the distance of the radium from the tissue, and therefore it is necessary to use as much rubber as possible outside the metal applicator. Every additional millimeter of rubber means additional distance and adds that much more chance of not traumatizing the other parts and of getting more uniformly distributed homogeneous dose of the radium itself.

I should have added that the gastrostomy tube should be left in place while traction is being made on the lower end of the thread to pull the radium down the esophagus to the proper site above and in the stricture; and with a forceps clamped upon it, the thread may be held in place. When we cannot use additional rubber on account of the small size of the lumen of the stricture, we use the smallest applicator and leave it in only a couple of hours. In a few days we can put in a larger applicator. We should not assume the full dose given until we can put in an applicator with at least a half centimeter of rubber around it.

If the patient refuses a gastrostomy, I then prefer the method brought out by Dr. Mills last year. In that way I have been able to canalize strictures which would not permit the passage of even the smallest olive. I hesitate very much to attempt to pass an olive in these cases, for the reason that we sometimes, under the fluorescent screen, see the wall of the esophagus above the stricture balloon out in a dangerous manner. The slightest additional pressure would surely make a perforation. Under the screen guidance, however, we are able to avoid this danger.

In most cases an adequate dosage will not be administered with the use of a single applicator. I have been using three, with a 100 mgm. applicator in the middle and one of 50 mgm. above and a similar one below.

RADIUM THERAPY OF VASCULAR NEVI*

BY HOWARD MORROW, M.D., AND LAURENCE R. TAUSSIG, M.D.

SAN FRANCISCO, CALIFORNIA

ONE of the most striking actions of radium on living tissue is that of producing an obstructive endarteritis in the smaller blood-vessels. This is one of the most useful properties of the rays in the treatment of neoplasms, probably extending the effectual zone considerably beyond the actual destructive zone by cutting off at least part of the nutrition of the growth. This more or less selective action on the blood-vessels was early recognized, and vascular nevi were among the earliest benign lesions treated with radium. Several investigators treated occasional vascular nevi with radium, but Wickham and Degrais were the first to systematize work along this line and to publish the results of a considerable number of cases. Some of the illustrations in their "Radium Therapy" show end-results which their successors may well envy. This was in spite of the somewhat hazy notions then held of the physics of radium. We are able to procure applicators containing a definite amount of radium element per unit of surface. Accurate investigations have been made on the effect of various screens, on the influence on the dosage of variations in the size of the applicator and its distance from the lesion to be radiated. This type of research is of great importance in taking radium therapy out of the field of empiricism and placing it on a sound scientific foundation which is essential to progress.

In the treatment of birthmarks, certain general considerations must be borne in mind. The work is done, as a rule, solely for the cosmetic result. Therefore it is preferable to remove a mark incompletely or not at all rather than to substitute for it a prominent, ugly scar.

Parents and relatives have frequently been led to expect that the nevus will be removed completely, leaving normal skin. It is true that in some of the best results the scar is scarcely noticeable, but there is always some atrophy, and even though the utmost care and skill has been used, telangiectases may occur. It seems that the skin over a vascular nevus develops telangiectasia more readily than other skin. These telangiectases can usually be removed satisfactorily by the water-cooled mercury lamp (Kromayer type) or by electrolysis or by the application of an acid. Experience has shown that the beta rays are more efficient in the treatment of vascular birthmarks than the gamma rays. They should be used whenever it is possible, but their usefulness is limited by their relative lack of penetration; and therefore, when the involvement is quite deep we must often use only the harder beta rays, and even exclusively gamma-ray radiation. In general it will be found that birthmarks of the vascular type are more amenable to radium therapy in young children than in adults, when bright red rather than when blue red, when smooth rather than when verrucous, and when the color can be readily and evenly obliterated by pressure.

There are numerous classifications of vascular nevi, none of which is entirely satisfactory. That which McKee adopted in "*X*-rays and Radium in the Treatment of the Skin" is a satisfactory working terminology. The true vascular nevi are divided into: nevus flammeus or port-wine mark, nevus vasculosus or strawberry mark and angioma cavernosum. These will be taken up separately as each requires a different technique and yields different results, though the essential pathology is similar. Spider nevi are not true nevi and should not be treated with radium.

Nevus flammeus is flat and varies in color from an almost indistinguishable pink to a deep purple red. It varies in size from that of a pinhead to that of a lesion which covers half of the head or more. The distinguishing feature is that it is not raised above the level of the surrounding skin. The color is usually homogeneous but it may be blotchy or there may be more or less numerous telangiectases. Occasionally angiomatous nodules are pres-

*Read at the Eighth Annual Meeting of THE AMERICAN RADIUM SOCIETY, San Francisco, Calif., June 25–26, 1923.

ent or may develop in a port-wine mark. A few capable radium therapists, notably Simpson in this country, report splendid success in treating this type of lesion, while most of the others advise against attempting to treat them with radium. All agree that a good result can be obtained in only a limited number of them, by the combination of considerable care and experience. We have never attempted to eradicate entirely one of these nevi, but we have in a very few instances attempted to pale out the lesion somewhat. The result has never been entirely satisfactory. Radium plaques or toiles are the only applicators suitable for this work. The weaker plaques, one-half or one-quarter strength, are preferable to the stronger ones. Toiles of about one-twentieth strength are useful but do not stand ordinary wear very well. Tubular applicators are not advisable. A very thin screen or no screen at all should be used. A quarter-strength, glaza plaque, screened with 0.1 mm. of aluminum or just covered with a layer of rubber dam, may be used for five to fifteen minutes on each area every three or four weeks. If a slight erythema is produced the dose should be cut materially the next time and the interval between treatments increased. The ideal dose is that which is just short of erythema. With this type of radiation, a moderately severe reaction will heal promptly without serious scar, but the probability of telangiectases and atrophy make it unsafe to cause more than the slightest erythema. Gamma and roentgen rays have practically no effect on these nevi. In most instances ultraviolet light treatment with the water-cooled mercury lamp is better, and radium therapy should be attempted only in small lesions in which the color is quite dark and evenly distributed.

Nevus vasculosus is raised above the nivus of the skin. This elevation varies from a scarcely perceptible swelling to two or three millimeters or more. The surface may be smooth or quite verrucous. The color varies from a pink red to a deep violet or bluish red. These appear most frequently on the face but may appear on any portion of the body, and they vary in size from that of a pinhead to that of a palm or larger. They are frequently about the size of a dime. Strawberry marks are present or appear shortly after birth and may grow for a time, but usually reach their maximum size early. Very rarely one of these marks undergoes spontaneous involution. When they are not complicated by a cavernous element, they are ideal subjects for radium therapy. A small superficial smooth lesion can frequently be cured by a single application. The dose used will depend very much on the type of lesion. One that is slightly raised, evenly colored and smooth should be given from twenty to forty minutes' exposure with a half- to quarter-strength plaque screened with 0.1 mm. of aluminum; while thicker lesions should receive from one to one and a half hours with a similar plaque screened with 0.3 mm. of brass or the equivalent. If there is any reaction from the first treatment, a second should not be given until it has faded entirely. If there is no reaction, practically the same exposure should be given in about three or four weeks. A lead-foil diaphragm must be used to protect the contiguous normal skin unless the applicator fits the lesion closely. Following an erythema there is usually an increase in the pigment around the area treated. This often persists for several months, but eventually fades entirely. If the first two or three treatments do not effect a satisfactory result, subsequent treatments should be spread over a considerable period of time. Should telangiectases occur, they are treated with ultraviolet light, the electric needle, or acid.

Cavernous angiomata may occur on any portion of the body. Their size varies from less than that of a finger-tip to that of a baseball. They are usually circumscribed, more or less spherical tumors, but they are occasionally quite diffuse. They are frequently entirely subcutaneous, without involvement of the epidermis, in which case they may be entirely colorless, though they usually present a faint blue or violet color. Angioma cavernosum is very often surmounted by a strawberry mark which may only partly cover the cavernous lesion or may be coextensive with it. These are more or less compressible, though they

may seem to be fluctuant. Occasionally one is seen with a pedicle, in which case it may be readily excised; but usually they present considerable resistance to surgical treatment. The technique of the radium treatment of these lesions is simple. Usually plaques of half or quarter strength are used and may be screened with 0.3 mm. of brass and an exposure of one to two hours given every four to six weeks over each area. If the lesion is large the principle of cross-fire can often be used to advantage. Most of these will require from nine months to two years for a satisfactory result. Tubular applicators may be used satisfactorily with a little care. A tube screened with 0.5 mm. of silver, held ½ cm. from the surface may be left in position to give 25 mgm hrs. to each sq. cm. of surface, using balsa wood, gauze, or some other light material to obtain the distance. Another form of therapy that has been used is intratumoral radiation, either from steel needles containing radium element, or from unscreened tubes of emanation. The steel needles, of 10 or 12 mgm., should be inserted 2 or 3 cm. apart and allowed to remain in place for not more than six hours. If bare tubes are available, they should be inserted into the base of the lesion and should contain 0.1 to 0.2 mc. of emanation each. The intratumoral radiation of cavernous angiomas has seemed rather radical to us and we have been loath to try it, although those who are using it are enthusiastic. This form of radiation may be combined with the ordinary surface radiation.

CONCLUSIONS

1. Our experience in treating vascular nevi with radium has shown that the results are better than with carbon dioxide snow or any other therapeutic agent.

2. Radium therapy is most satisfactory in treating nevus vasculosus, next in treating cavernous angioma and least satisfactory for nevus flammeus.

3. Beta rays should be utilized as much as possible.

4. Severe reactions are not justifiable.

DISCUSSION

Dr. Sanford Withers, Denver, Colo. I think the paper very well sums up the consensus of opinion regarding the treatment of this type of angioma. We quite agree with Dr. Taussig that the port-wine marks are the hardest to treat, but it is almost impossible not to get good results in treating the strawberry marks with infrequent, short exposures to radium plaques.

We have been getting away from radium in the treatment of port-wine stains. It may be of interest to describe what we are using. It is the mercury vapor arc lamp of the water-cooled variety; and, not content with one blister, as soon as the first one can be peeled off we blister again in a period of from one to two weeks and then wait a month to note the effect. It is remarkable to see how quickly these port-wine stains that are irregularly distributed will disappear. We have occasionally given five or six blisters in a period of six weeks, but that is unusual. This treatment produces a pigmented zone that exists around the area for months but gradually fades away; and the appearance of the treated area blends into the normal skin and leaves an area not nearly as marked as the postage-stamp reaction from a radium plaque.

I wish to lend my emphasis to the fact that beta radiation is the thing to use in these cases. It has been used ever since Wickham and Degrais brought out the toile of low activity. This has tempted me into the use of beta radiation for the large cavernous angiomata. In order to eliminate skin reactions as much as possible, I have been using imbedded tubes of low activity, from 0.2 to 0.3 mc. each. An attempt is made to produce a complete retrogression of the lesion at one sitting. This method gets the crying youngster out of the office quickly and eliminates the possibility of the applicator becoming displaced during treatment.

I think there is a definite place for the compression bandage during the radium application and particularly with the use of the bare tubes or needles. I believe we increase the action. I like to make the compression firm, and press out as much of the blood of the cavernous nevus as possible.

I heartily agree that we are never justified in producing more than an erythema for the ordinary superficial variety of nevus. I think most men are likely to push their treatment too far.

I would like to know what experience these gentlemen have had in the treatment of lymphangiomas and whether there should be any difference in the method used.

Dr. H. N. Cole, Cleveland, Ohio. I like this paper very much, and the thing I liked particularly was the conservatism. If anything, I want to go even further in my conservatism

than the authors have. I think a reaction to radium in angiomata is never justifiable. In an angioma we have something that the public will look upon for the rest of the patient's life, and it is not necessary for it to clear up in a few weeks. It is better to take several years if necessary to get a better result. Two things are necessary in the treatment of these cases, one radium and the other time, and I lay more emphasis on time than on radium. We use radium too often in angiomas and I have learned by bitter experience in some of my first cases that it is much better to go slowly and to put lots of accent on the "slowly." Treat them once in two or three months, as Dr. Withers said, and use light doses. The results are better than even if you use a light exposure and use it frequently. In one type, the port-wine stain, we can get better results with the quartz lamp. We give an exposure of not more than five or ten minutes using a half-strength plaque and screen of 0.2 mm. aluminum and tell the patient to come back in two or three months. Do not be in any hurry to use another application. This holds true in the strawberry nevus as well. It is not necessary to cure them in six months, and it is much better to wait for a year. I have had too many cases come in a year or two after treatment with telangiectasia and tell-tale postage-stamp mark that will be carried all through life; and I am convinced that it is far better to go slowly and avoid the danger of these results.

In the treatment of cavernous angiomata I think again we should go slowly. Allow plenty of time between the exposures. I think the compression bandage is a good thing. By the compression you will expose the cells to more radium than you could otherwise and get a much better result. Do not give enough radium therapy to cause any effect on the skin.

I do not think there is much difference between the treatment for lymphangiomata and for angiomata. You get very good results on either the skin or the mucous membrane. I have had several cases of lymphangioma of the tongue and have had satisfactory results with surface applications and cross-fire.

Dr. R. H. Stevens, Detroit, Mich. I am heartily in accord with most of what has been said regarding the treatment of nevi with radium. I began treating with the Finsen light some twenty years ago and we got some very good results. Since then I have used the quartz light with satisfactory results and have also had good results with radium therapy, particularly in the small lesions, when it is used in quite young children.

I wish to emphasize Dr. Cole's remarks about time. Delay the treatments, giving long periods between them. I have treated nevi and have not repeated the treatment for six months or a year. If you watch carefully you will see the nevus disappear gradually over a period of a year or eighteen months. In the case of a little girl who was treated with a small amount of radium for a cavernous nevus' on the end of her nose, I treated it when she was two or three months old, and when I saw her recently there was no atrophy of the skin, and one could not tell that there had been anything wrong with it. The result was perfect. I agree that most of these cases are treated too frequently and I advise not repeating the treatment within three, four or six months, or possibly a year.

I recently had some experience with an aneurysm around the mouth, with large vessels through the skin and mucous membrane of the cheek. We used heavy doses of radium, well filtered, and got rid of most of the vessels so that I could turn the patient over to the surgeon for the eradication of the large vessel. Before treatment it was really a serious condition with the mucous membrane pressed in against the teeth. The improvement was marked.

Dr. R. E. Loucks, Detroit, Mich. I am very glad to hear of the conservatism that is shown in the treatment of these lesions. I described a method of treatment with a flat applicator several years ago. The child is brought to the office and given a feeding so as to produce sleep. The skin over the lesion and the rubber dam covering the applicator are sprinkled with talcum powder to prevent adhesion, and the applicator is ironed over the area with sufficient pressure to flatten out the superficial blood-vessels. In this way you avoid the outline of the applicator, and are not so likely to have telangiectasia. The reaction from each treatment should be noted, for no two treatments in different individuals are alike. The blond child may have an erythema in ten or twelve minutes, while the brunette may require fifteen or eighteen minutes.

In the treatment of lymphangiomata, we had one case of the tongue where the condition was classified as macroglossia. The child's tongue protruded through the lips, and it could only eat by sucking. It could not close its teeth, as the development of the jaw was so interfered with by the tongue that there was an opening of an inch between the anterior teeth. The child could not go to school because of this deformity. We obtained excellent results, and within eight or ten months the tongue was reduced in size, so that it could be kept inside of the teeth, and by means of a dental splint the jaw was changed so that the

teeth articulated. I am convinced that slow treatment in all these conditions is the better plan.

DR. MORROW. We have had no experience with lymphangiomata, all our work having been done with the angiomata.

DR. TAUSSIG (closing discussion). I think the ground has been very well covered and am glad that everybody agrees on conservatism, and that some go even further than we do in this regard.

One thing that we have found useful, is the application of a few drops of flexible collodion on the surface of the plaque, attaching it to the angioma or strawberry mark. Of course, that is just the opposite of the plan spoken of by Dr. Loucks, but I think if the surrounding tissue is screened with lead foil one is sure to get the action in exactly the place desired instead of half an inch below.

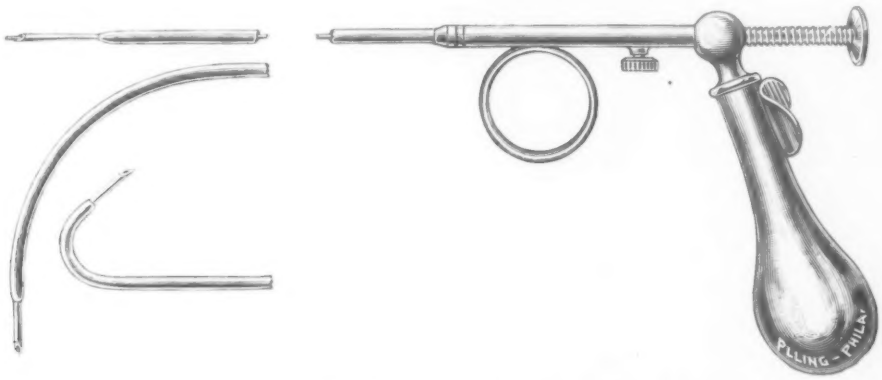
AN INSTRUMENT FOR THE IMPLANTATION OF BARE RADIUM EMANATION TUBES INTO THE TISSUES

BY WILLIAM NEILL, JR., M.D.

Associate Surgeon, Howard A. Kelly Hospital

BALTIMORE, MARYLAND

NUMEROUS instruments have been devised for permanent implantation of bare glass radium emanation tubes into the tissues. In 1920 Dr. Robert M. Lewis (at that time an associate at this hospital) had made an instrument for implanting these tubes into the female bladder through the Kelly aero-cystoscope. This instrument was similar in principle to the ones shown here, but owing to mechanical difficulties, it did not prove practical. A short time afterwards, I had three types of instruments made for this purpose by the George P. Pilling and Son Company of Philadelphia, Pa., which have been entirely satisfactory.



A steel cannula with a needle point 2 cm. long and 2 mm. in diameter is attached to a large handle placed at an angle which affords a good grip and a finger catch for counter pressure against the thumb push. The radium tubes are ejected from the needle into the tissues by means of a stylet running the entire length of the instrument.

The first type is applicable for all oral, intravesical, vaginal and rectal cases. The second is so curved that all intralaryngeal growths can be accurately implanted. The third is curved at the end and can be used with accuracy in a number of cases for implanting tumors of the nasopharynx.

At the time of treatment it is preferable to have the desired number of instruments previously prepared to facilitate the implantation in order that it will not be necessary to rethread the same instrument a number of times.

It is important that the point of each instrument be dipped into sterile boric ointment or vaseline immediately after the emanation tube has been threaded into it. This acts as a good adhesive plug and prevents the dislodgment of the tube prior to its implantation. While not in use, the instruments are kept immersed in kerosene, which not only lubricates, but prevents rusting of the stylet.

THE TREATMENT OF BENIGN HEMORRHAGE OF THE FEMALE GENITOURINARY TRACT BY RADIATION*

BY HENRY SCHMITZ, M.D., AND HARRY E. BUNDY, M.D.

CHICAGO, ILLINOIS

THE value of radium and the *x*-ray in the treatment of benign hemorrhage of the female genitourinary tract has led to the universal employment of these agents by radiologists and many surgeons. While this method of treatment has given negative results in the hands of those unfamiliar with its limitations, statistics are giving us more confidence that the results obtained are valuable.

Benign hemorrhages of the uterus amenable to radiation treatment fall into the following groups: (1) Essential menorrhagia or hemorrhagic metropathies; (2) myomata uteri; (3) inflammatory adnexal disease; (4) pernicious bleeding during gestation.

In the treatment of these conditions it is imperative to rule out malignant disease. To accomplish this it is necessary to do a careful diagnostic curettage of the endometrium, and, if necessary, excise a piece of the cervix if this shows evidence of abnormal change. It is important also to exclude disturbances due to the endocrine system, as menorrhagia is frequently found in thyroid and pituitary disorders. All tissues removed should be given very careful microscopical examination.

In treating the hemorrhagic metropathies we use a 50-mgm. capsule of radium element. The dosage varies with the age of the patient. In adolescent women and in those desiring offspring we give small doses, 300 mg. el. hrs. being sufficient. Should this dose be insufficient to bring about a normal menstrual flow we repeat the application after an interval of six months. This dose corresponds to an inflammatory ovarian dose, with the *x*-ray corresponding to a 25 per cent E. S. D. applied to the ovaries. The ovaries are 6 to 7 cm. beneath a plane drawn through the anterior superior spinous process of the innominate bones. Hence, using a 140 kv. maximum current, a filter of 0.5 mm. copper and a focal skin distance of 50 cm. and 5 ma., the time duration would be one hour through the anterior field.

In older women from thirty-five years on, the gamma-ray dosage must be 600 to 1,200 mg. el. hrs. to cause a destruction of the endometrium. The dosage of *x*-ray to cause cessation of ovulation and destruction of the primordial follicles is 50 per cent E. S. D.

Women who have passed the menopause we treat as though carcinoma were present, even though there is no microscopic evidence of malignancy. Both radium and *x*-rays are used. We have had two such patients return with a recurrence of the uterine hemorrhage and positive evidence of malignancy; and therefore we insist that the combined treatment be given in each case.

In our series of 116 hemorrhagic metropathies there have been 9 cases treated twice and 4 cases treated three times. There has been one fatality, occurring three days after treatment from septic peritonitis.

As regards the myomata the only symptom requiring radiation treatment is hemorrhage—usually menorrhagia. Myomata causing pressure symptoms, undergoing degeneration, complicated by adnexal disease or submucous fibroids, or those located in the cervix should not be treated. Myomata larger than a four month's pregnancy should not be subjected to radiation treatment unless constitutional contraindications to hysterectomy are present. Women of the child-bearing age should be myomectomized.

In our series of 54 cases of myomata 2 patients were found to have sarcomatous degeneration within six months after treatment and a hysterectomy was performed. One patient was operated upon for a submucous fibroid. In all the other cases amenorrhea or oligomenorrhea was attained.

The object of ray treatment is arrest of the menorrhagia. In one-third of the cases, the myoma will decrease in size or disappear entirely simultaneously with the process of senile atrophy. It is impossible to bring about a decrease in the size of the myoma in all cases.

* Read at the Eighth Annual Meeting of THE AMERICAN RADIUM SOCIETY, San Francisco, Calif., June 25–26, 1923.

Small fibroids up to the size of a grapefruit may be treated with radium alone; those larger than this should have *x*-rays or a combination of the two. Adenomyomata should be removed surgically if possible—otherwise treated as though malignant.

In treating benign hemorrhages of the uterus the radium capsule must be placed against the fundus. If placed accidentally near the internal os, destruction of the mucous membrane lining the internal os may occur, the result being atresia with a subsequent pyometra, hydrometra or hematometra, necessitating a hysterectomy for relief.

The menorrhagias or metrorrhagias accompanying adnexal disease and the pernicious bleeding from different parts of the body during the pregnant state are often intractable to the usual forms of treatment. Though the adnexal disease may be clinically or surgically healed, uterine hemorrhages may persist even after repeated curettages.

These hemorrhages respond almost immediately to an exposure of the spleen to a stimulating dose of rays of about 15 per cent E. S. D. We cannot explain the mode of action, as it contradicts the teachings of physiology that stimulation of the spleen reduces the coagulability of the blood. Should the bleeding persist after twenty-four hours, twice the dose is given.

We have treated 14 cases of adnexal disease, 4 febrile abortions, 2 resulting from uterine myomata and 2 gestation hemorrhages. In 19 cases cessation of the bleeding took place within twenty-four hours and in 3 cases an additional ⅔ E. S. D. was applied after forty-eight hours with prompt cessation of the hemorrhages.

It is stated that removal of the spleen causes hyperfunction of the ovaries; therefore increased activity of the spleen with an irritating *x*-ray dose would reduce ovarian function.

In conclusion, radium and the *x*-ray do not supplant surgery. Radiation therapy must be accepted as one of the best methods for the treatment of the hemorrhages of benign uterine and ovarian diseases. However, its limitations have been definitely recognized and should be strictly observed. Only then can we avoid the many pitfalls which the injudicious use of an otherwise valuable therapeutic agent will cause.

DISCUSSION

Dr. James T. Case, Battle Creek, Mich. I was very much interested in the statistics given by the authors, particularly in the last class of patients, and in the results reported from radiation of the spleen in controlling hemorrhage. I understand that the ordinary methods of testing the coagulation time are of questionable value. Dr. Bundy's report is not based upon any test of coagulation time, but upon actual cessation of hemorrhage, which is a very practical proof. I have attempted a number of experiments for estimating any possible change in the coagulation time in connection with routine irradiation for carcinoma and fibroids. I have been unable to find any constant change. I am also aware that the literature is not at all in agreement regarding the experimental results. I would be glad if the authors would explain further their theory as to the cause of cessation of hemorrhage through the external application of radiation to the spleen.

Dr. Henry J. Ullmann, Santa Barbara, Calif., I would like to add something in the way of experience with coagulation time. Last year, while radiating the abdomens of rabbits in order to produce gastric ulcer, we were taking blood from the ear veins to make counts. We found that there was a steady drop in the coagulation time following radiation and within a day or two of their death, from perforated gastric ulcer, it was impossible to get enough blood from their ears to make a count. At that time when exposing the rabbits I was about twenty feet away, with no protection except the ordinary glass bowl and two plaster walls between myself and the machine. A film exposed in the same room was fogged. My coagulation time fell from seven minutes to around thirty seconds. I was not able to get it under the microscope soon enough to get the coagulation time and it took nearly a week to return to normal.

A few weeks ago when giving heavy radiation for an abdominal tumor I found a definite drop of about 50 per cent and it returned to the patient's normal in about twenty hours. The same drop occurred at the second radiation. We are continuing the work on animals and may have something definite in a few months.

Dr. Sanford Withers, Denver, Colo. I do not believe that Dr. Schmitz wishes to leave the impression I received, that the effect

of the radiation causing a cessation of menstruation is essentially on the ovary. Personally I have seen 2 cases that had the old classical operation of castration done and developed a menorrhagia that was controlled by intrauterine radiation.

Dr. H. H. Bowing, Rochester, Minn. I was interested in what Dr. Schmitz had to say about the carcinomatous change and would like to hear further elaboration on the 2 cases mentioned.

Professor Lars Edling, Lund, Sweden. I have had occasion to give radium treatment for metrorrhagia and myoma of the uterus at frequent intervals since 1910 and have treated in this way something like 200 or 250 cases of bleeding uterus, both the metrorrhagia and menorrhagia types, and I think about 50 to 60 cases of myomata. In the first class I have used, as a rule, 4 mgm. of radium with a filter of ½ mm. of lead and some rubber. In the myomata I have used about the same dose but in some cases have used 16 mgm., with an extra filter of 1 mm. of silver. The results have, as a rule, been very good in the bleeding cases. In a small number of cases I have been obliged to repeat the irradiation, and this has been done routinely at least two months after the first exposure; generally not much more. That length of time gives an opportunity to observe the character of the patient's bleeding during two menstrual periods. In most cases the bleeding has ceased and in only a small number of cases have there been repeated attacks of hemorrhage. These have been controlled by means of repeated radiation, usually one treatment; but in 2 cases two doses were given. In the myomata the results have not been quite so good. There have been a certain number of cases of infection and I think they have all been due to submucous myomata being implanted by the irradiation of metrorrhagia. In such cases extirpation of the uterus has been necessary. In the last several years, therefore, I have used *x*-ray treatment with radium, with good results. This has been about our experience in the treatment of these disorders.

Dr. Schmitz (closing discussion). We began irradiations to the spleen for the arrest of bleeding about two years ago, prior to the time that any reports had come from Central Europe on similar investigations. The first case was a young woman who was pregnant. She had pernicious bleeding from the gums. She had received four huge transfusions of blood. The improvement lasted for a day or two and then she would bleed again. I advised the extract of the placenta to stop the bleeding, without any result. I then suggested radiation of the spleen, giving an irritating dose, i.e., about 15 per cent to the organ. Within two days she stopped bleeding and carried the child to full term. Labor was normal and the child was perfectly developed. We then began to pay close attention to similar cases.

In bleeding uteri a action of the *x*-rays is confined to the ovary, while that of the radium is confined to the endometrium. If we use radium we apply a dose that will destroy the surface of the endometrium. Without endometrium the menses will cease.

In one case a sarcoma was overlooked. The patient did not have the sudden increase in size of the tumor or the sudden and alarming bleeding that we usually find in malignancy, and we were under the impression that we were dealing with myoma of the uterus, and rayed it accordingly. Hemorrhage ceased. But soon she had an involvement of the lymph-nodes. We resorted to a hysterectomy and found a sarcomatous degeneration of the myoma. In the second case we made a wrong diagnosis. The patient had a large solid tumor in the pelvis, about the size of a fist. It appeared to be one with the uterine organ and was movable with it. She was fifty-six years old and had not ceased menstruation. We applied radium, but the tumor continued to grow, the patient developed pain and seemed to get worse. At first she refused to return to the hospital. Finally she came back and at that time we found an invasion of the anterior abdominal wall and lymph-nodes. Laparotomy revealed a large sarcoma of the ovary. The uterus was not involved. A panhysterectomy was done, followed by *x*-ray irradiation. She is at present in better health than she has been for years.

The only indication for irradiation that we recognize in benign conditions of the uterus is the presence of one symptom, namely, hemorrhage. If any other symptoms are present, such as pain or pressure, we refuse radiation treatment. If in doubt we prefer to subject a patient to hysterectomy or myomectomy.

A PRELIMINARY REPORT OF THE ACTION OF BURIED RADIUM ON DISEASED THYROIDS IN MAN

BY J. O. BOWER, M.D., F.A.C.S., AND J. H. CLARK, M.D.

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PHILADELPHIA, PENNSYLVANIA

WE HAVE previously reported experimental work on the implantation of radium needles in the thyroids of dogs.[1] Our results indicated that normal thyroid tissue is resistant to the action of unscreened radium rays and we feel that, owing to this resistance, implantation of radium needles for a comparatively long period of time is a better therapeutic measure in man than surface applications. In addition to our experimental biologic evidence certain physical facts must be borne in mind in making this deduction. First, the action of radium is intensified many times by burying it in tissue, since one obtains the necrotizing action of the beta rays in addition to the effect of the gamma rays. Furthermore, the action of the gamma rays diminishes with the distance, as the square of the distance.

Witherbee[2] gives his *x*-ray dosage for the treatment of tonsils, adenoids and goiter as a 7-in. spark-gap, 5 ma., 10-in. distance, four minutes' time, the rays being filtered through 3 mm. of aluminum. While we are not in a position to compare accurately the dosage, one may get a fair idea by comparing the potential of surface application of radium with that of *x*-rays, which is 1,000,000 volts radium as compared with the maximum 200,000 for *x*-rays, a 20-in. spark-gap being essential. If we consider the proper dosage for surface application to be 1,600–3,000 mgm. hrs. (radium applied 2½ cm. from skin surface) then, according to Viol[3] and others, the outlying cells, those farthest away from the action of the radium rays, will receive sixteen times as much radiation with the embedded radium as with the surface application.

These facts have led us to employ larger doses of buried radium in thyroid disease and the clinical results obtained so far seem to justify the procedure.

Terry,[4] has reported very favorable results in exophthalmic goiter from the use of buried radium emanation tubes, but used doses much smaller than we have employed, while several men have obtained good results from surface applications. Abbe,[5] was the first to use buried radium in exophthalmic goiter and employed in a single reported case the massive dose of 2,400 mgm.

We wish to report briefly 3 cases of thyroid disease, each differing from the others, in all of which we employed comparatively large doses of buried radium.

FIG. 1. Case I. May 28, 1922. Recurrent carcinoma of thyroid before radium treatment.

In two the diagnosis was confirmed by histologic examination of tissue.

Case I is one of recurrent carcinoma of the thyroid (Figs. 1–6).

Case II is one of simple colloid goiter (Figs. 7–9) complicated by carcinoma of the larynx with a slightly increased basal metabolic rate, decreasing under radium treatment.

Case III represents a rather typical toxic goiter, not confirmed by histologic examination, but which shows a clinical cure within six months after two doses of buried radium (Figs. 10–11).

CASE I. Female.

Family History. Negative.

Previous Personal History. Negative.

Menstrual History. Normal until March 9, 1922, when the flow became profuse. This was of three weeks' duration and unaccompanied by pain.

Present Illness. In January, 1919, patient developed tonsillitis which confined her to bed for several days. About two weeks later, she noticed a swelling in the anterior aspect of cervical region, left. About February 1st, of the same year, this had attained the size of a hen's egg. Patient stated that it was painless; that it moved when she swallowed and that she noticed no change in her eyes at that time. About February 1, 1922, the swelling increased in size very rapidly. This was accompanied by severe pain, especially in bad weather. About this time she noticed that her eyes became more prominent, that her heart beat more rapidly and that she became rather nervous. On May 3, 1922, she consulted Dr. W. W. Babcock, who advised operation. This was done at the American Stomach Hospital, May 9, 1922, under local anesthesia. The growth measured 10 × 7 × 3 cm., and on section appeared sarcomatous in nature. Microscopic examination, however, by one of us, disclosed it to be carcinoma (Figs. 2–5). On May 8, 1922, the patient was referred to one of us with a recurrence of a growth on the left anterior cervical region anterior to the sternomastoid. The growth measured 5 × 4 × 2 cm. In the center of the necklace incision was a granulating area about 1½ cm. in diameter.

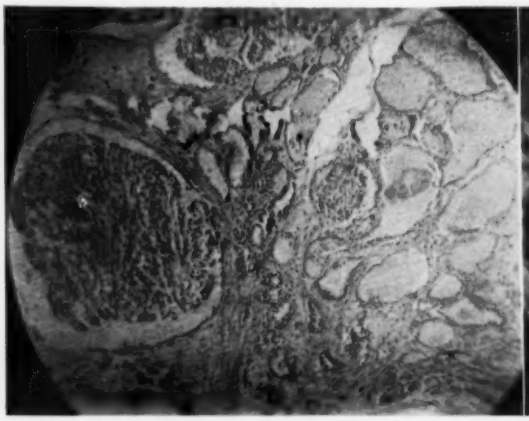

FIG. 2. Case I. Low-power photomicrograph near edge of advancing carcinoma. Some follicles contain colloid, others are filled with proliferated epithelium. Compare with Figure 3.

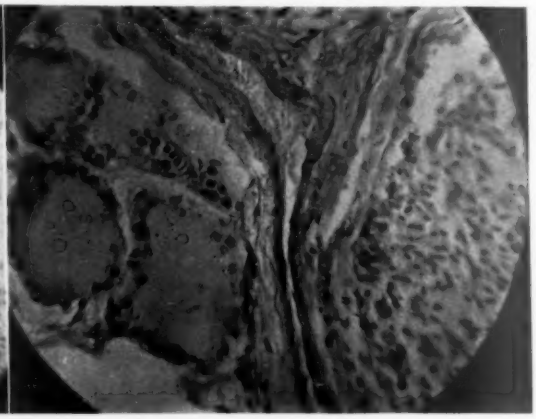

FIG. 3. Case I. High-power photomicrograph near edge of advancing carcinoma. Compare with Figure 2.

FIG. 4. Case I. Low-power photomicrograph of fully developed carcinoma. Compare with Figure 5.

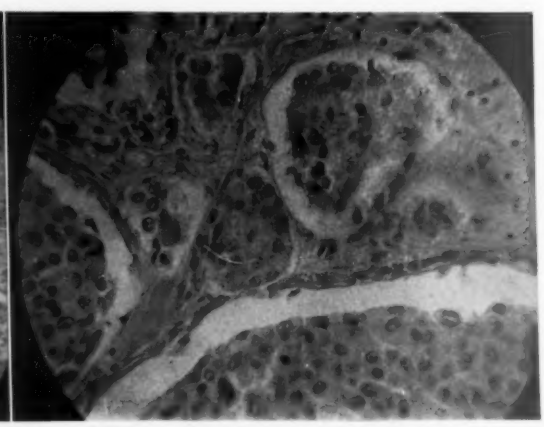

FIG. 5. Case I. High-power photomicrograph of fully developed carcinoma. Compare with Figure 4.

On May 28, 1922, two 12½-mgm. needles were inserted into the growth and 25 mgm. placed directly over (26 mm. distant) for a period of forty-eight hours, and 25 mgm. over the granulating area in the center of the incision. At the end of three weeks the granulating area had healed and the growth had diminished one-half in size. At this time 25 mgm. were again inserted into the growth twenty-six hours. At the end of two months it had diminished to one-third its size, and at the end of three months had disappeared except for a moderate amount of induration.

Subsequent History. About six months after application, patient suddenly disappeared and all efforts to locate her have been unsuccessful.

CASE II. Male, aged forty-seven years. Entered hospital December 11, 1922.

Complaint. Hoarseness of voice.

Family History. Negative.

Past Personal History. Negative.

Present Illness. First noticed hoarseness in July, 1922; since that time he has lost 4 lbs. in weight. Two years previously had noted a swelling in the lower part of his neck which has gradually increased in size.

Physical Examination. Height 65 in.; weight, 117 lbs.; caries and pyorrhea; enlarged tonsils; thyroid enlarged, irregular and pulsating. Heart rapid, 180; blood pressure 125–80; blood count 3,960,000 reds, 5,800 whites; hemoglobin 70; polymorphonuclears 67; lymphocytes, small 27; large 2; mononuclears 2; transitionals 2; Wassermann negative; sputum negative for tubercle bacilli. Urinalysis negative; examination of larynx showed a small whitish pedunculated mass about 12 × 6 × 4 mm. lying between the vocal cords. This, on a second laryngoscopic examination, was spontaneously coughed up and proved to be a squamous-cell epithelioma. Basal metabolic rate, January 1, 1923, was plus 44. January 16, 1923, plus 28. On January 27th, 1923, under local anesthesia, a 6 cm. horizontal incision was made over inferior portion of left lobe of thyroid; the ribbon muscles were retracted and eight 12.5 mgm. needles inserted into the gland. Radium was removed at the end of twenty hours. March 8, 1923, gland was about half original size; voice slightly improved. Laryngoscopic examination shows growth to be about one-half former size. Basal metabolic rate plus 17½. Five 12.5 mgm. needles were again inserted into the thyroid gland for twenty-four hours and 37.5 mgm. placed directly opposite in order to obtain maximum cross-fire effect. Patient discharged from hospital at the end of thirty-six hours.

Remarks. Seven days after re-insertion of radium needles, patient without interrogation remarked that tonsils were very much smaller; that they used to touch each other. No change in size of gland.

FIG. 6. Case I. August 26, 1922. Photograph three months after initial radium treatment. Area of moderate induration at site of growth. General health much improved.

March 27, 1923, patient returned for observation. Thyroid gland normal in size. Tonsils reduced to one-third original size; growth in larynx very much smaller. Pulse 120; weight 120½ lbs. Voice improved. Surface application 2400 mgm. hrs.

April 17, 1923, thyroid of normal size; tonsils showed no change since last examination; growth in larynx slightly larger. Dr. T. C. Davis of the Nose and Throat Department of the Samaritan Hospital, Philadelphia, devised a special applicator for introduction of radium directly to the growth, but it was impossible to keep it

in position for more than a few minutes. In order that direct application could be made to the growth, tracheotomy was advised, and the patient at the present time has this under consideration.

CASE III. Male, aged thirty-six years.
Family History. Negative.
Past Personal History. Negative.
Complaint. Loss of weight; nervousness; bulging in neck; diarrhea.

FIG. 7*a*. Case II. Photograph before implantation of of radium needles.

FIG. 7*b*. Case II. Photograph after implantation radium needles.

In this case it was thought that the thyroid was involved in the malignant process; unfortunately, a section of the gland was not removed at the initial radium treatment. The section removed one month later showed no malignant change (Fig. 8). The second application was not necessary from the standpoint of treating the goiter, but it was decided that the maximum radiation of the laryngeal growth could be attained with the needles in this position.

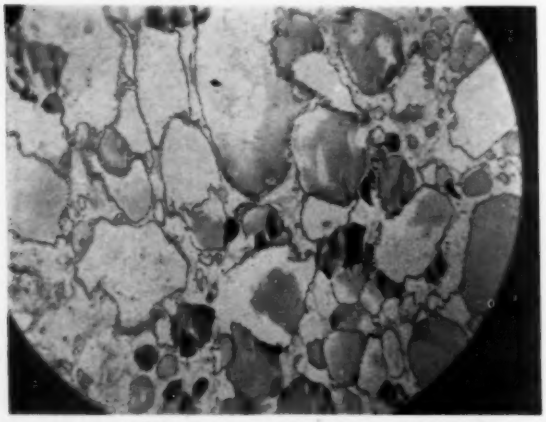

FIG. 8. Case II. Note irregular-sized follicles, flattened epithelium and irregular distribution of colloid.

In November, 1922, patient developed within a few days a globular swelling in the left anterior cervical region about the size of a small orange. He became nervous; complained of palpitation, dyspnea after exertion, epigastric discomfort immediately after eating, sour eructations, fulness and a persistent diarrhea.

FIG. 9. Case II. Showing radium needles in enlarged isthmus and left lobe of thyroid.

Physical Examination. Showed what appeared to be an adenomatous growth of the thyroid about 7 cm. in diameter. subsequent operation disclosed that the quinine and urea supposedly injected into the gland usually reached only the capsule)

FIG. 10a. Case III. Photograph showing patient before implantation of radium needles.

FIG. 10b. Case III. Photograph showing patient three months after implantation of radium needles; patient has gained 31 lbs.

Area of heart dulness increased to the left. Pulse rate, 140; blood pressure—systolic 140, diastolic 80. There was a marked tremor and sweating of the hands. Basal metabolism was attempted on seven occasions but patient was extremely nervous and results were unreliable. Patient, being of Italian origin, could speak but little English and we were unable to assure him of the harmlessness of the procedure.

December 19, 1922, under local anesthesia, eight 12.5 mgm. radium needles were inserted into the enlarged lobe of the thyroid, using a special applicator devised by Dr. Cameron of the Radium Chemical Company of Pittsburgh. They were withdrawn at the end of ten hours. The patient left the hospital at this time. Wounds healed primarily.

On examination, December 26, 1922, skin showed slight reaction; no change in size of thyroid. Pulse 120; symptoms unchanged.

January 3, 1923, goiter slightly smaller; pulse 108; other symptoms unchanged.

January 19, 1923, after considering our own and the experience of others, in injecting the thyroid with quinine and urea (since in a large percentage of instances it was decided that it would probably be better to expose the thyroid and insert the

FIG. 11. Case III. Showing radium needles embedded in left lobe of thyroid.

radium directly into the gland proper. This was done, making a 6-cm. incision, about 1 cm. above the upper border of the

clavicle. We were unable to find any evidence or show that the capsule had been penetrated by the needles. There was evidence of muscle change but no adhesions could be found. Eight 12.5-mg. needles were inserted directly into the gland after retraction of the neck muscles. They were removed at the end of twenty hours.

February 2, 1923, wound healed without complication. No change in size of growth pulse 108; sweating of hands somewhat diminished; diarrhea has subsided.

March 1, 1923, patient feeling much better; has returned to work. Growth in neck much smaller; pulse 90; bowel, movements normal; tremor less. No sweating of hands.

April 15, 1923, improving in health; gained 15 lbs.; growth has almost disappeared; pulse 84; digestion good; bowels move normally; no tremor.

May 15, 1923, patient has gained 30 lbs.; never felt better; working eight hours daily; pulse 80; no tremor; digestion good.

Remarks. In order to be certain that any result obtained in this case was due to the action of the radium alone, the patient was not put at rest. For the two treatments he was confined to bed thirty hours. He was given no medication and was permitted to eat anything. It will be noted that the improvement began about the time cicatrization was completed.

CONCLUSIONS

1. Three different types of thyroid disease are reported in which large doses of buried radium were employed.
2. The large dose was well borne and gave no untoward symptoms.
3. The use of buried radium needles is a feasible therapeutic measure and gives reliable results. We believe that radium is far superior to the injection of boiling water, quinine and urea, or polar ligation; that it is indicated in cases that are poor operative risks.
4. Owing to the apparent resistance of thyroid tissue to radium rays, as found from experimental work, it is urged that those using radium in thyroid disease employ comparatively large doses of buried element.

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A COMPARATIVE STUDY OF THE EFFICIENCY OF VARIOUS FILTER MATERIALS*

BY ARTHUR W. ERSKINE, M.D., AND SCOTT W. SMITH, M.S.

CEDAR RAPIDS, IOWA

A FILTER is an absorber. Its efficiency depends upon the fact that it absorbs *x*-rays in proportion to their wave-lengths, that is, it absorbs proportionately fewer short than long waves. The ideal filter would absorb *all* rays of more than the desired wave-length, but would not absorb any rays of shorter length. Our problem is to determine what filters approach most nearly the ideal, or, what filters absorb the maximum of long waves and the minimum of short ones. The obvious method to be employed in such a comparative study would be to interpose various filters in the path of a beam of *x*-rays, produced under fixed conditions, and then by analyses of the spectra of the filtered beams, determine the effects of the filters upon wave-length. The technical difficulties of such a method are great, and a moment's reflection shows one that a much simpler and more direct solution of the problem is available. We endeavor to obtain a beam of *x*-rays with a high proportion of short wave-lengths, not because there is any especial therapeutic virtue in short wave-lengths, but because they are more penetrating. Since penetration is inversely proportional to wave-length we can omit all measurements of wave-length, and confine our study to the effect of various filters on penetration. The degree of penetration can be shown by the ratio between the surface and depth intensities in a water-phantom. It is proper to assume that the most nearly ideal filter will be the one which permits the delivery of the highest percentage of surface radiation to the depth, when compared to other filters which equally increase the length of time required for the administration of a surface dose.

In accumulating the data for this study, the voltage, current, size of field and anode surface distance were fixed. Readings were made of the time required to discharge the electroscope with the ionization chamber at the surface of a water-phantom and at a depth of 10 cm., using unfiltered rays first, and then gradually increasing thicknesses of the various filter materials investigated. From these readings two graphs were plotted for each filter (Figure 1). The one which we may, for convenience, call the surface dose, shows how the time in seconds required to discharge the electroscope with the ionization chamber at the surface of the water increases with the addition of each layer of filter. The graph called, for convenience, the depth-dose percentage, shows how the percentage of the surface dose reaching a

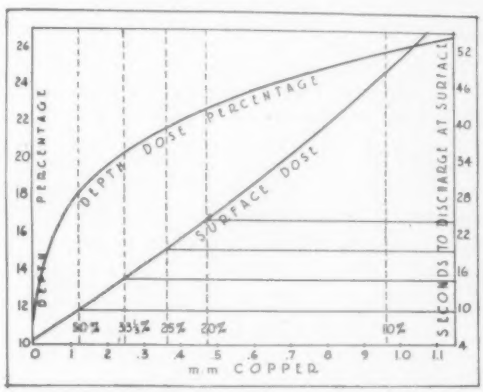

FIG. 1. Specimen graph showing the surface dose and the depth dose percentage with various thicknesses of copper. 140 kv., 2.5 ma., 10 cm. field, and 40 cm. anode surface distance.

depth of 10 cm. increases with the addition of each layer of filter. The points on the latter graph are obtained by dividing the number of seconds required to discharge the electroscope with the ionization chamber at the surface by the time in seconds required to discharge the electroscope with the ionization chamber at the depth. From the surface-dose graph we may also determine what part of the original beam of *x*-rays is absorbed by any given thickness of filter, and what thickness of filter is required to absorb any given percentage of the original beam. For

* Read at the Fourth Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, Louisville, Ky., Feb. 24, 1923.

example, when enough filter has been introduced to reduce the rate of fall of the gold leaf of the electroscope to one-half what it was when no filter was used, it is evident that 50 per cent of the original beam has been absorbed. If the electroscope discharges only one-fourth as rapidly as when no filter is used, three-fourths of the beam has been absorbed and only 25 per cent remains. By comparing the depth-dose percentage graphs of two or more filter materials at points where equal percentages of the original beams have been absorbed, the relative efficiency of the materials is easily shown.

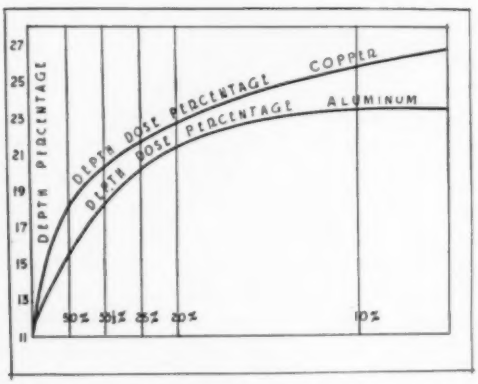

FIG. 2. Comparative depth dose percentage graphs with copper and aluminum filters, plotted according to their absorption values. 140 kv., 2.5 ma., 10 cm. field and 40 cm. anode surface distance.

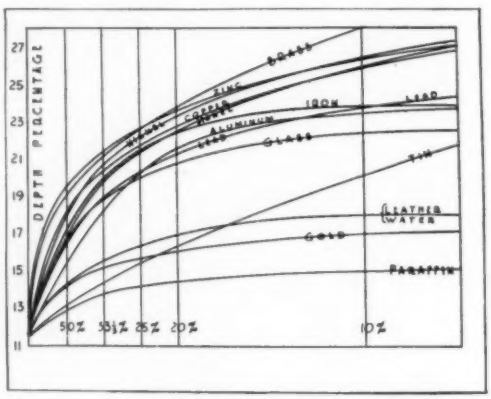

FIG. 3. Comparative depth dose percentage graphs with various filter materials, plotted according to their absorption values. 140 kv., 2.5 ma., 10 cm. field and 40 cm. anode surface distance.

In Figure 2 the depth-dose percentage graphs of aluminum and copper are both plotted according to the absorption values of the materials instead of their actual thickness. When enough aluminum has been introduced to reduce the intensity of the unfiltered beam to 50, 25 and 10 per cent, respectively, the depth-dose percentages are 15.5, 20.1 and 23.4, respectively. Corresponding depth-dose percentages with copper filters are 18.1, 21.7, and 25.8, respectively; showing that copper is considerably more efficient as a filter than aluminum.

In Figure 3 the depth-dose percentage graphs of all the materials studied are plotted according to the absorption values of the materials. The more efficient filters are the elements, copper, iron, nickel and zinc, and their alloys, brass and monel metal. The atomic weights of these elements range from 55 to 65, and their atomic numbers from 25 to 30. Elements with higher or lower atomic weights and atomic numbers are less efficient.

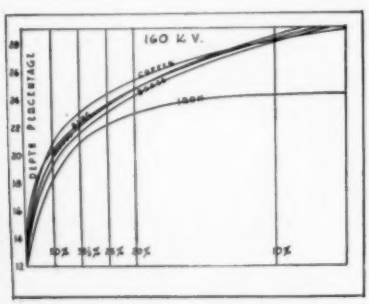

FIG. 4. Depth dose percentage graphs of the more efficient filters. 160 kv., 2.5 ma., 10 cm. field and 40 cm. anode surface distance.

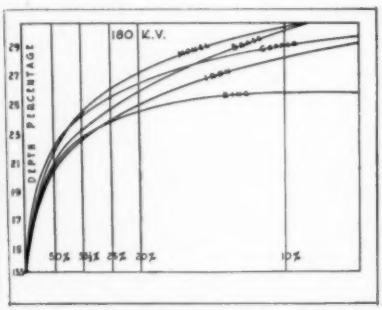

FIG. 5. Depth dose percentage graphs of the more efficient filters. 180 kv., 2.5 ma., 10 cm. field and 40 cm. anode surface distance.

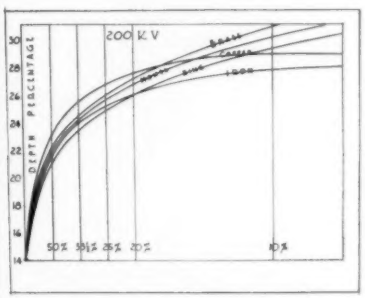

FIG. 6. Depth dose percentage graphs of the more efficient filters. 200 kv., 2.5 ma., 10 cm. field and 40 cm. anode surface distance.

TABLE I.—DEPTH DOSE PERCENTAGE

Material	At. Wt.	At. No.	50 Per Cent	33⅓ Per Cent	25 Per Cent	20 Per Cent	10 Per Cent
Brass	.....	.....	19.0	21.0	22.5	23.8	28.0
Zinc	65.4	30	19.2	21.3	22.6	23.7	26.2
Nickel	58.7	28	17.8	20.6	22.2	23.2	26.2
Copper	63.6	29	18.1	20.3	21.7	22.7	25.8
Monel	.....	..	16.5	19.7	21.3	22.5	25.8
Iron	55.8	26	16.9	19.6	21.4	22.5	23.8
Aluminum	27.1	13	15.5	18.3	20.1	21.5	23.4
Lead	207.2	82	16.4	18.8	20.2	21.2	23.6
Glass	.....	..	17.2	18.8	19.9	20.6	22.3
Leather	.....	..	14.4	15.6	16.4	16.9	17.8
Water	.....	..	14.2	15.5	16.4	16.8	17.8
Gold	197.2	79	14.5	15.1	15.5	15.9	17.0
Tin	118.7	50	12.5	14.2	15.5	16.5	20.1
Paraffin	.....	.....	13.3	13.8	14.1	14.3	14.9

All the foregoing data were obtained by measurements of *x*-rays produced at 140 kv., 2.5 ma., diameter of field 10 cm., and anode surface distance, 40 cm. The measurements were repeated with the more efficient elements and alloys at 160, 180

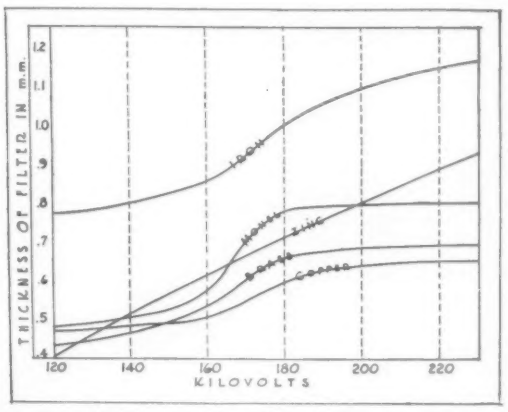

FIG. 7. Thicknesses of copper, iron, zinc, brass and monel metal absorbing 80 per cent of the total beam of *x*-rays at various voltages.

and 200 kv., the results being shown in Figures 4, 5 and 6 respectively.

An interesting fact which can be demonstrated on all the graphs, with all the materials and voltages studied, is that the limit of economical increase in filter thickness varies with the voltage. It corresponds approximately to the thickness which will absorb 80 per cent of the unfiltered beam of *x*-rays, or to express it differently, is the filter thickness which multiplies the time of the unfiltered dose by five. The thicknesses of the various more efficient elements and their alloys which will absorb 80 per cent of the unfiltered beam at various voltages are shown in Figure 7.[1]

SUMMARY

1. Since filter efficiency depends upon the wave-lengths in the filtered beam, and since penetration is inversely proportional to wave-lengths, the relative efficiency of various filter materials may be determined by a comparison of their effects on penetration.

2. Such a comparison may be made by measuring the effect of various filters on the ratio between the surface and depth intensities in a water-phantom, provided that the *x*-rays measured are produced under fixed conditions.

3. The most efficient elements studied are copper, iron, nickel and zinc, ranging in atomic weights from 55 to 65, and in atomic numbers from 25 to 30.

4. The most efficient alloys studied are brass and monel metal, which are alloys of the same elements.

5. Because of the efficiency and desirable physical properties of the alloys they should receive further study and investigation.

[1] The experimental work of this investigation was performed in the radiological research laboratory of Coe College, under the general supervision of Dr. L. D. Weld, of the Department of Physics.

A WATER-COOLED HIGH-VOLTAGE X-RAY TUBE*

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1. INTRODUCTION

IN a paper read before the Radiological Society of North America in December, 1922, one of the authors described experimental tubes in which the anode consisted of a solid plate of tungsten in the form of a circular disc 4 in. in diameter. These tubes were operated in water-cooled oil and ran steadily with as much as 50 ma. at 200,000 volts. On life-test, one of them ran continuously for forty hours with 30 ma. at 200,000 volts and was still operable.

An interesting difficulty manifested itself when these tubes were operated continuously. The inner surface of the glass became roughened locally and in places serious erosion developed. It was suggested that this action might be due, primarily, to an electrolysis of the hot glass of the bulb, and secondarily, to positive ion or other bombardment resulting from the continuous evolution inside the bulb of the products of such electrolysis.

While the experiments already referred to indicated that a satisfactory high-power tube of the type in question could be made, it appeared desirable to see whether there was not some easier solution of the problem. With this end in view, work was undertaken, and finally carried to a successful conclusion, on a high-power high-voltage tube with a water-cooled anode.

Some work had already been done on a high-power water-cooled tube for lower voltages and in 1915 one of the authors had reported on this work.[1] Excellent performance had been obtained with tubes carrying as much as 100 ma. at 140,000 volts (max.) Only one serious difficulty had been encountered in this work and this was in connection with the target. On continuous operation, minute cracks would develop in the target metal in the neighborhood of the focal spot, and these cracks would gradually deepen until they finally extended through the tungsten face of the target and through the copper backing. These cracks permitted water to leak right into the tube. The effect was due to the forces of expansion and contraction brought into play by the intermittent character of the (alternating current) discharge. The tube was operating on 60 cycle alternating current, and, as a result of this, 60 times per second the target face was heated and caused to expand and 60 times per second this heated metal was chilled by the cooling water applied to the back of the target, and caused to contract.

[1] COOLIDGE, W. D., AM. J. ROENTGENOL., Jan., 1914, i, 115.

2. THE TUBE

Before attempting to design a water-cooled target for a high-voltage tube, a study was made of the water-cooled tube referred to in the preceding paragraph. It was found that, in general, the tearing action of the discharge was greater the higher the temperature gradient in the target. This is illustrated by the fact that one tube had shown a life of 1,500 hours with a load of 50 ma. at 70,000 volts (max.) and that the target of this tube was still intact, whereas another tube with this same target design had shown a target life of less than one hundred hours when operated at 100 ma. and 70,000 volts (max.), that is, with essentially only twice the temperature gradient in the target.

To reduce the temperature gradient in the target of the new tube, the focal spot area was greatly increased and three different designs of target were tried (Fig. 1). In the first (A) a section of small seamless copper tubing was wound around and silver-soldered to a cylinder of copper with a tungsten plate cast in one end. In the other two (B and C) square or round copper tubing was wound up in the form of a spiral and silver-soldered to the back of a thin disc of copper carrying a thin tungsten plate cast in the face. The two latter types possess the advantage of lighter weight, more uniform temperature gradient between focal spot and water, and easier construc-

* Read at the Twenty-fourth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Chicago, Ill., Sept. 18–21, 1923.

tion. Type C proved somewhat easier to construct that B owing to the fact that the round tubing could be more easily brought into the required form without producing undue strains which might lead to cracks.

A complete tube with an anode of Type C is shown in Figure 2. The ends of the copper tube coming from the back of the target are brought out through a larger copper tube (a) with a vacuum-tight silver-soldered joint at the inner end of (a). The distinctive feature of this construction is the use of a seamless metal tube to conduct the water in and out of the *x*-ray tube, the solder between tubing and target being depended upon only for making thermal contact, and not for making a vacuum-tight joint. The copper tube (a) is joined to the glass tube (b), (the re-entrant portion of the anode arm) by means of the thin platinum sleeve (c). To increase the effective length of the anode arm, a tube of solid dielectric (d) is slipped over the small copper tubes and held in place by means of the cap (e) of insulating material which is cemented to the outer end of the arm.

The glass bulb is 8 in. in diameter.

The cathode is the same as that found in the Universal type of tube except that a small projecting pin (f) of molybdenum has been located in the center of the filament spiral, the function of the pin being so to change the electric field about the cathode as to produce a large focal spot.

A pinhole-camera picture of the focal spot of one of these tubes is given in Figure 3. In this case the focal spot was 1⅛ in. in diameter.

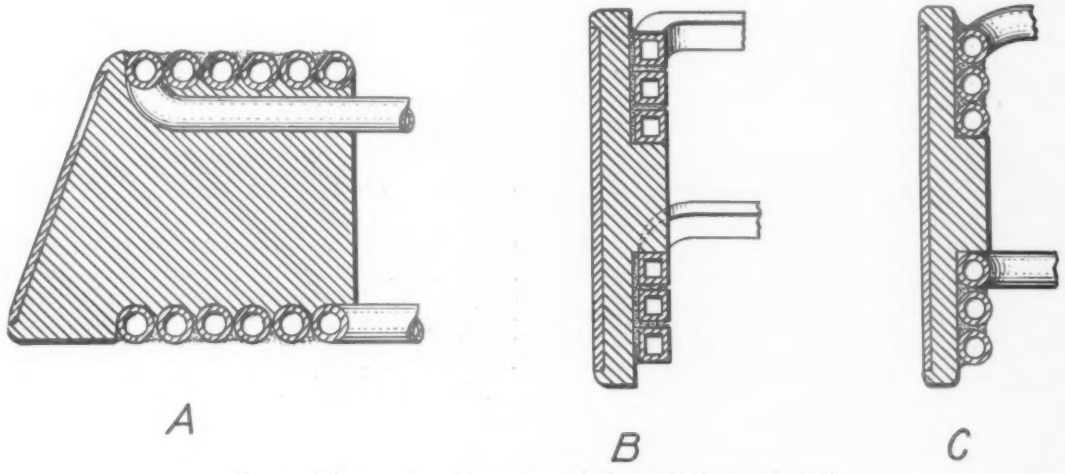

FIG. 1. Three types of water-cooled anode (natural size).

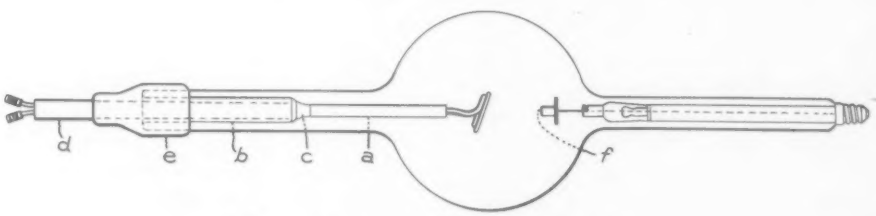

FIG. 2. Water-cooled high-voltage tube.

3. GENERATING OUTFIT

The operation of such a water-cooled tube at high currents and voltages was found to be most satisfactory on a generating outfit consisting essentially of a high-tension transformer, rectifying switch and resistance control.

The most suitable transformer used was a large experimental one designed espe-

cially to give close regulation. The switch was of the four-arm type and utilized about 70 per cent of the wave. When the tube was operating at 50 ma. and 250,000 volts, sufficient ballast resistance was used in the control to reduce the voltage from 250 (line voltage) to about 195 (55 volts being consumed in the resistance).

4. ACCESSORIES

For the operation of a high-voltage water-cooled tube, an insulated water

FIG. 3.

system is desirable. The experimental installation employed (Fig. 4) consisted of a No. 23 Brown and Sharpe bronze gear pump (a) driven by motor (b) through an insulating shaft (c), and a cellular type Ford radiator (d) cooled by air forced through a tunnel (e) made of insulating material, from an 18 in. Davison blower (f). Water connections between pump and tube, and between tube and radiator, were made through flexible tubing (g).

The pump was driven at such a speed that it circulated about 4 liters of water per minute through the anode at about 30 lbs. pressure. With a tube load of 50 ma. at 250,000 volts, the temperature of the water as it left the anode was 70°C. and the temperature was lowered to 50°C. in the radiator. A gear pump was chosen in preference to a centrifugal pump because it assured a continuous flow of water, and furthermore, gave the pressure necessary to force sufficient water through the small copper tubing.

It was necessary to provide some means for guarding against failure of the water circulation while the tube was operating, as such failure would involve the immediate destruction of the target. This assurance of an uninterrupted water supply was secured by installing a section of Sylphon tube (f) on the high-pressure side of the pump and connecting one end of the Sylphon chamber of a rod (i) operating contacts (j) in the circuit of a relay which controlled a contactor located in the primary circuit of the *x*-ray transformer.

Details of this safety device are given

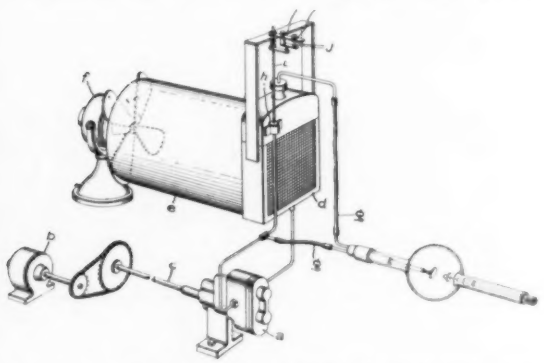

FIG. 4. Water-cooled high-voltage tube and accessories.

in Figure 5. It is evident from this diagram that, unless the contacts (a) are brought together by expansion of the Sylphon tubing (b) due to pressure of the circulating water, the contactor (c) will not be operated and current cannot pass through the primary of the *x*-ray transformer (d).

A similar safety device to assure sufficient cooling of the water might be designed to be operated by air from the blower or by the temperature of the water itself.

5. CAPACITY OF THE TUBE

Tubes of the type described above have been operated in the laboratory at 50 ma. and 250,000 volts max. This was a load of

approximately 9 kilowatts. One tube was operated for 50 hrs. at this load without any change in the behavior of the tube.

With suitable design, this type of tube could apparently be made to handle even much larger amount of energy.

6. X-RAY OUTPUT

With such a high-power tube, it became interesting to measure the *x*-ray intensity delivered when operating with various

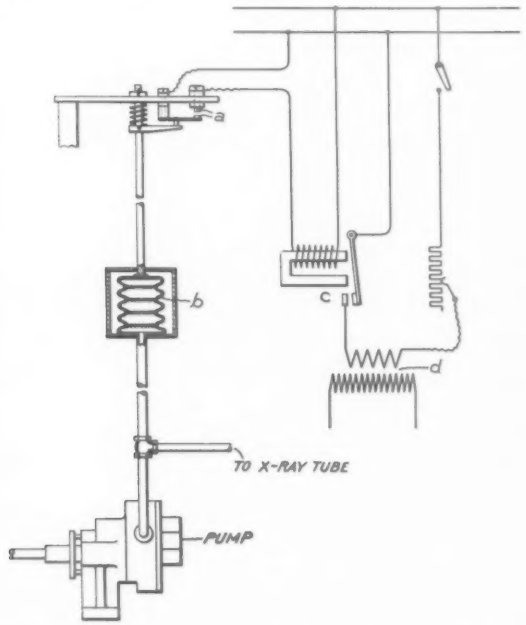

FIG. 5. Diagram of safety device to prevent closing of *x*-ray circuit without water flowing through tube.

tube currents and at different voltages. This was done with an ionization chamber and a gold leaf electroscope, the measurements being made under a 1 mm. filter of copper. The graphs shown in Figure 6 give the *x*-ray intensity, expressed in arbitrary units, obtained with tube currents of from 1 to 50 ma. and voltages of 200,000 and 250,000 (max.). The graphs are not straight lines and indicate that, over this wide range of current, *x*-ray intensity at a given voltage was not proportional to milliamperage.

It seems very probable that there is a distortion of wave form, increasing with load, and that this distortion is of such a nature as to decrease the efficiency of *x*-ray production.

It seemed worth while to study the relation between energy input and *x*-ray output. Most of the energy in the high-tension current delivered to the *x*-ray tube is converted in the target into heat, and a measurement of the temperature of the water, as it enters and as it leaves the target, together with a measurement of the amount of water flowing through the target, gives data from which the energy input may be calculated. Such measurements were made with the various tube-currents employed in making the above-

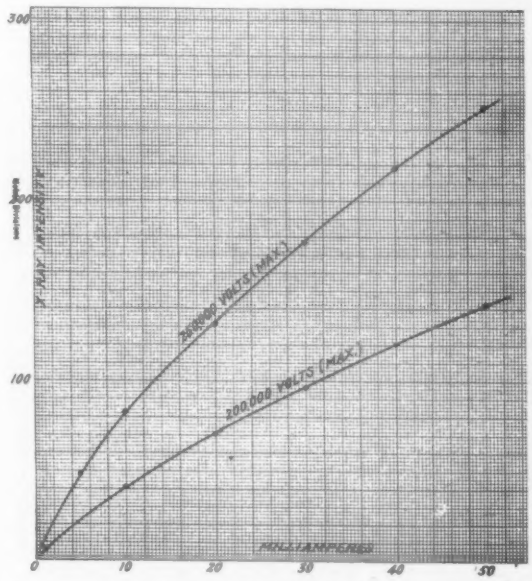

FIG. 6. Curve showing relation between *x*-ray intensity and milliamperage.

mentioned intensity curves at 250,000 volts. The data are given in Table 1 and the energy values taken from the last column are plotted on the upper curve in Figure 7. Beside this curve is given the *x*-ray intensity curve for the same voltage. (The values for the curve given in Figure 6 were multiplied by an amount necessary to make the two curves coincide at the 50-ma. point.) The two curves are practically identical, showing that the *x*-ray output, as measured in the manner already described, was very closely proportional to energy input.

7. EFFECT OF GENERATING OUTFIT ON X-RAY OUTPUT

Various high-tension transformers, rectifying switches and controls, and various

types of generating outfits were used with the water-cooled tube, and, as a result of this experience, the following general conclusions may be drawn:

(*a*) The electrical characteristics of the generating outfit have a marked effect upon the behavior of the system and upon the *x*-ray output.

(*b*) With the interrupterless type of machine, the system operates best when a large amount of ballast resistance is used in the low-tension circuit of the *x*-ray transformer. With auto-transformer control and no ballast resistance, bad surges take place.

high-voltage tube and the water-cooled tube operating on various types of generating apparatus are given in Table II. The measurements were made with the ionization chamber 1, under 1 mm. of copper filter.

In 1, the next to the last column of the table, is given a number of ratios of *x*-ray intensities.

From the first group 1 it is seen that under the same conditions, the Universal high-voltage tube and the water-cooled tube give the same *x*-ray intensity.

From 1, 2, 3, 4 and 5 the following conclusions may be drawn:

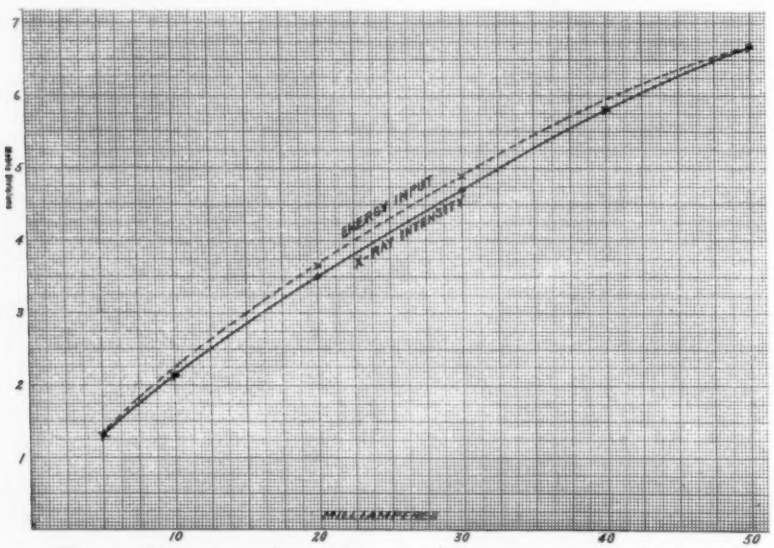

FIG. 7. *X*-ray intensity and energy input at 250,000 volts (max.).

(*c*) With the interrupterless type of machine, with the same switch and the same control, the *x*-ray output, for the same milliamperage and voltage, is different with different high-voltage transformers.

(*d*) With a constant-potential continuous-current outfit[1] the *x*-ray output is greater, for the same values of tube current and voltage, than it is with the interrupterless type of machine.

(*e*) When rectifying its own current, the tube does not operate satisfactorily with as high voltages as it will satisfactorily handle on rectified current.

Data obtained in making *x*-ray intensity measurements with the Universal type

In terms of the *x*-ray intensity delivered by the Universal type high-voltage tube when operated at 5 ma. and 200,000 volts (which is perhaps the average current and voltage employed with this tube) the water-cooled tube gives:

At 30 ma. and 200,000 volts, 4.30 times as much *x*-ray intensity.

At 30 ma. and 250,000 volts, 8.27 times as much *x*-ray intensity.

At 50 ma. and 250,000 volts, 14.1[1] times as much *x*-ray intensity.

At 50 ma. and 250,000 volts, 15.1[1] times as much *x*-ray intensity.

According to 6 the constant-potential continuous-current machine, operating the water-cooled tube at 10 ma. and 200,000

[1] COOLIDGE, W. D., and KEARSLEY, JR., W. K. High voltage *x*-ray work. AM. J. ROENTGENOL., Feb., 1922, ix, 77.

[1] Note that two different transformers are involved in these ratios.

volts, gives 1.82 times the *x*-ray intensity obtained from the interrupterless type of machine when operating the tube at 10 ma. and 200,000 volts (max.).[1]

8. APPLICATIONS

1. *Medical. Therapy.* In the preceding section it has been shown that there may be obtained with the water-cooled tube under certain conditions an *x*-ray intensity fifteen times as great as that usually obtained with the Universal type high-voltage tube. The question of the desirability of such an increase in *x*-ray intensity in therapeutic work must, of course, be left to the medical profession.

The tube can also be used with the lower values of current and voltage now generally employed, and experience may show that it has a sufficiently longer life than that of the Universal type high-voltage tube to justify the added complications inherent in water cooling.

The distribution of intensity in the radiated tissues will be somewhat affected by the increase in the size of the focal spot over that ordinarily employed.

2. *Industrial. Metal Radiography.* The same considerations which may make the tube interesting for the medical application apply in the field of metal radiography also.

The tube in its present state of development has a focal spot which is large for radiographic work. It seems probable, however, that a similar tube of equal capacity could be developed with a considerably smaller focal spot.

9. SUMMARY

A new type of tube with a water-cooled anode is described. This tube satisfactorily handles as much as 50 ma. and 250,000 volts and, with suitable dimensions, could apparently be made for much larger amounts of energy.

Generating apparatus and auxiliaries, suitable for operating this type of tube with as much as 50 ma. and 250,000 volts, are described.

The effect of the electrical characteristics of the generating outfit on the behavior of the system and on the *x*-ray output is discussed.

The data given show that, with the high currents and voltages used and the interrupterless type of machine, *x*-ray intensity was not proportional to milliamperage, owing probably to distortion of wave-form. It was, however, essentially proportional to energy input.

Possible medical and industrial applications are discussed.

In conclusion, it gives pleasure to the authors to acknowledge the valuable assistance of Mr. George Hotaling and Mr. Leonard Dempster, in carrying out the work which has been described.

TABLE I

Tube-Current (Milliamperes)	Temp. Water Entering Tube (T_1) Degs. C.	Temp. Water Leaving Tube (T_2) Degs. C.	$T_1 - T_2$	Liters of Water per Minute	Kilowatts Input
10	31.7	38.3	6.6	4.8	2.20
20	35.5	46.5	11.0	4.8	3.67
30	41.4	56.3	14.9	4.8	4.96
40	45.9	63.5	17.6	4.8	5.88
50	49.7	69.7	20.0	4.8	6.67

TABLE II

Tube	Generating apparatus	Ma.	Kv. (Max.)	X-ray intensity, I	$\frac{I_a}{I_b}$	Group
Universal high-voltage	A	5	200	0.0185(*a*)	1.00	1
Water-cooled	A	5	200	0.0185(*b*)		
Water-cooled	B	30	200	0.0943(*a*)	4.30	2
Water-cooled	B	5	200	0.0219(*b*)		
Water-cooled	B	30	250	0.1796(*a*)	8.27	3
Water-cooled	B	5	200	0.0217(*b*)		
Water-cooled	B	50	250	0.2718(*a*)	14.1	4
Water-cooled	B	5	200	0.0192(*b*)		
Water-cooled	A	50	250	0.2718(*a*)	15.1	5
Water-cooled	B	5	200	0.0179(*b*)		
Water-cooled	C	10	200	0.0704(*a*)	1.82	6
Water-cooled	A	10	200	0.0386(*b*)		

A = Interrupterless Machine consisting of a four-arm switch, a resistance control and a large transformer designed for very close regulation.

B = Interrupterless Machine consisting of the same switch and control used in A and a smaller transformer.

C = Constant Potential—Continuous Current.

The constants of the measuring device were the same for both members of each group of measurements, but may have changed for the different groups. For this reason, the values of *x*-ray intensity for the same tube load are not the same in the various groups.

[1] The voltage with the interrupterless machine having been measured as maximum and not effective voltage, this ratio is to be divided by 1.4 if a comparison between the two machines is to be made on the basis of energy input. It should also be noted that although the constant-potential continuous-current machine may work satisfactorily as a laboratory outfit, it has not yet been developed to a point where it could be considered a reliable piece of apparatus for the doctor's office.

DISCUSSION

DR. D. R. BOWEN, Philadelphia, Pa. I would like to ask Mr. Moore whether the difference in the *x*-ray output of the two interrupterless machines A and B was due to differences in switches, controls or transformers.

MR. MOORE (closing discussion). The difference in the *x*-ray output of the two generating outfits A and B could not have been due to differences in switches or in controls as the identical switch and the identical control were used for both outfits. The only part of these outfits which was not common to both was the transformer. The transformer of outfit A was much larger than that of outfit B and had been designed to give very close regulation. This close regulation doubtless resulted in less distortion of wave-form and hence in higher efficiency of *x*-ray production.

MEASUREMENTS OF THE ABSORPTION COEFFICIENT OF WATER AND ALUMINUM FOR HARD X-RAYS

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THE absorption coefficient of any radiation, including the *x*-rays, is defined by the following equation:

$$I = I_0 e^{-\mu(\lambda,Z)d}$$

in which I_0 is the intensity of the beam when it enters, and I that of the beam when it leaves, the absorbing medium; d is the layer thickness, e the base of the hyperbolic system of logarithms; $\mu(\lambda,Z)$ is termed the absorption coefficient, the latter being a function of the wave-length λ and the absorbing atom's atomic number Z.

The absorption coefficient consists of two coefficients: the pure absorption coefficient $\bar{\mu}$ and the scattering coefficient σ.

$$i.e.: \mu(\lambda, Z) = \bar{\mu}(\lambda, Z) + \sigma(\lambda, Z)$$

In order to determine the absorption coefficient of the *x*-rays by experiment it would be necessary to work with monochromatic radiation. If there is no such radiation, but a heterogeneous one, this radiation must either be decomposed into a spectrum, or, as would be sufficient for practical purposes, be made by sufficient filtration into such a part of a spectrum that the absorption coefficient would become independent of the absorbing medium's layer thickness. This is what we call "practical homogeneous radiation," and it is always used in deep therapy. For its "dosage" it is absolutely necessary to know exactly the absorption coefficient of water and aluminum.

A great number of measurements of the absorption coefficients in question have already been made. Part of them give us variations from each other; first of all measurements of the absorption coefficient of water, which lately have been executed by Glasser,[1] who—with the same maximum tension (200 kv.)—obtains a value approximately 30 per cent higher than that which is generally used in deep therapy.

The purpose of the following work is to execute as exactly as possible the measurements of the absorption coefficient in water and aluminum for hard *x*-rays, and to try to explain the cause of the differences mentioned above.

In order to get an exact measurement of the absorption coefficient the following must be observed:

The source of radiation has to work constantly and it must be possible to establish it very exactly with respect to its quality and quantity of radiation. The condition of practical homogeneity must be fulfilled by proper filtration.

To characterize the quality of the radiation, i.e., of the practical homogeneous radiation also, the easiest way is to take the limiting wave-length that results from the maximum potential at the tube by the equation of Planck-Einstein:

$$h\nu = eV \text{ or } \lambda_0 = \frac{12.34}{\text{kv.}}$$

[1] Following the isodoses charts of Glasser, 200 kv. (peak) .75 Cu. + 1 Al. μ water = .180, λ effect. = .15 Å. U.

As to the ray's path, it must be such that the quality and quantity of rays is not altered by any foreign influences, i.e., the beam of rays must, by adapting the diaphragms, be kept sufficiently parallel and very fine and protected against an exterior undesirable radiation.

In order to diminish as far as possible any measuring faults by scattering rays it is advisable to place the absorbing body in the middle of the *x*-rays' path. Furthermore the same must be so thick that the intensity of radiation, measured once with and once without absorbing medium, gives us differences sufficiently great; this applies especially in the case of water, of which the absorption coefficient is comparatively small.

In case measuring should be done according to the ionization method, the chamber must be rather large, because if too small a chamber is used, one cannot make sure whether it really works in proportion to the intensity or not.

For the experiments an AEG Coolidge tube with tungsten anticathode was used, fed by a transformer apparatus, and with the spiral heated by a battery of accumulators. This apparatus allows us the use of voltages higher than 200 kv. and of a tube current more than 4 ma., without altering the tension at the tube. The primary voltage could be kept by ohm resistance on a point of .1 volt constantly, which means a secondary one of about 200 volts. The tube current could be kept on .02 ma. constantly.

A lead wall 4 mm. thick (A, Fig. 1) perforated at the level of the anticathode is put in front of the tube R at a distance of 22 cm. from the focus. On the side looking to the tube is a small lead tube T, supplied with a lead diaphragm, receiving the main filters (Cu. and Al.) used for making homogeneous the *x*-rays. On the other side of the lead wall A is a lead tube 3 cm. in diameter, 4 mm. thick and 30 cm. in length, which has diaphragms M on its ends and one inside as well. The first of these consists of a 2-mm., the other two of 2-cm. pieces of brass. On the other end of this tube there is placed another lead wall 4 mm. in thickness, behind which stands the water basin G_1 and G_2. Behind the water basin is the electroscope[1] collimator, 30 cm. in length, with 2 diaphragms M, each consisting of a 2-cm. piece of brass. Each of the diaphrams has a 1-cm. hole

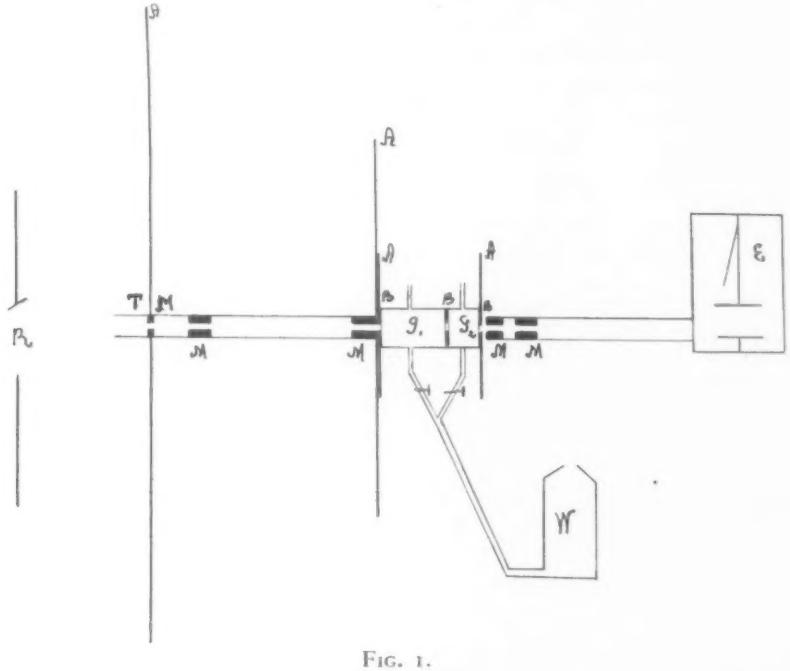

FIG. 1.

[1] Winawer. Back's electroscpe, constructed by the Voifa-Werke.

The water basin is built according to the instructions of Glocker.[1] It is composed of two brass tubes, 4 cm. in diameter, 5 cm. and 10 cm. in length, respectively, which are kept together by a piece of brass tube. The ends of the tubes are closed by glass plates of 1 cm. thickness. Besides these, there are 3 lead diaphragms, B, 4 mm. thick, each with a 1-cm. hole. By raising and lowering the water jug W one or the other or both the tubes can be filled with water.

The measurement itself takes place as follows: Tension and tube current are established at a certain value and the tube put in action for half an hour, because the tube current is constant only after this period of time. Afterwards the intensities are measured with and without the measuring body by the falling time of the electroscope filament. To control the constancy of the intensity, it is measured for each layer thickness first without, then with, and afterwards again without, the measuring body.

The said arrangement allows the falling time to be determined within $\pm .2$ sec.

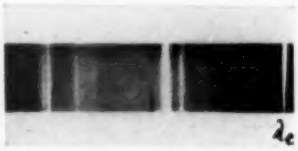

FIG. 2.

Unwanted rays are examined by closing the tube T with piece of lead of 1 cm. thickness, in which case the electroscope filament did not fall down visibly in a period of 600 sec., with a voltage between 150 and 200 kv. and with a 3 ma. tube current in use.

In order to make homogeneous the radiation, filters of copper and aluminum are used, the thickness of which is varied, until the same absorption coefficient is found with every tension used for 5, 10 and 15 cm. of water.

To determine the quality of the radiation and also the absorption coefficient of a practical homogeneous radiation, one wants the exact knowledge of the limiting wavelength. Therefore one must establish as exactly as possible the maximum voltage at the tube. As a matter of fact, the measurement of it by sparking distance, as it is often executed, only gives us an idea of the maximum voltage. The spectrographic method was taken, even against the common opinion that if high voltages are used, the limit of the short waves does not come out clear, and that therefore it becomes very difficult to fix the voltage

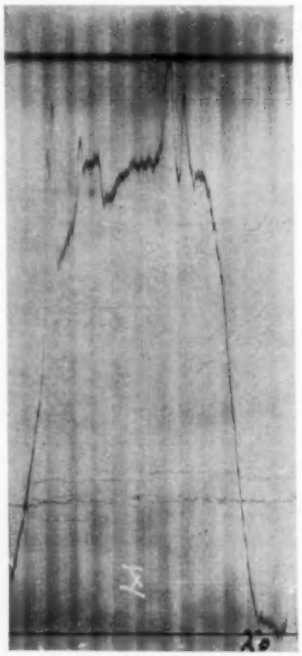

FIG. 3.

by the equation of Planck-Einstein. The spectrometers were built following the system of Seemann.[1] There were three of them in use. The one containing the best crystal was used in the final measurements. Twenty-two spectrograms, between 150 and 220 kv. were made, whereby the tube current and voltage were carefully kept on the same point. To be independent of the network fluctuations, these spectrograms were taken during the night, part of them before starting, part in the middle and the rest at the end of the work. The two last series were photometered by the registering photometer of P. P. Koch[2] for control. The result was a number of spectrograms showing a limit sufficiently clear. Figure 2 shows one of the registered

[1] Glocker, Rothacker und Schönleber. *Strahlentherapie*, 1922, xiv, 393, Figure 2.

[1] Seemann, H. *Phys. Zischr.*, 1917, xviii, 242; and 1920, li, 1919.
[2] Koch, P. P. *Ann. d. Phys. u. Chem.*, 1912, xxxix, 705.

curves and Figure 3 the spectrogram belonging to it.

The values found for the limiting wavelength λ_0 and the tensions belonging to them are to be seen in Table I.

TABLE I

Primary Voltage at the Transformer (Relative Values)	λ_0 in Å.U.	Secondary Voltage in Kv.	
37	.071	173	first series
42	.062	199	
33	.083 (8)	147.5	second series
33	.084	147.7	
35	.077	160.5	
38	.069	179.0	
40	.064 (8)	191.0	
40	.065	190.5	
42	.061	202.0	
42	.060	203.6	
44	.058	212.0	
46	.056	220.0	
33	.0813	151.7	third series
33	.0811	152.1	
33	.0809	152.5	
35	.0763	161.7	
35	.0760	162.3	
35	.0758	162.9	
39	.0688	179.4	
39	.0687	179.6	
42	.0613	201.3	
42	.0608	202.9	

The greatest error of all the measurements is ± 1.5 per cent. We used only the values of the third series. For, taken with the very best spectrometer, they show the most exact limit and the minimal differences between. Here the greatest error is $\pm .5$ per cent.

Table II gives the voltages used for the measurements of the absorption coefficient.

TABLE II

Primary Voltage at the Transformer (Relative Values)	λ_0 in Å.U.	Secondary Voltage in Kv.
33	.081	152.1
35	.076	162.3
39	.069	179.5
42	.061	202.1

For each of these four tensions a great many measurements of the absorption coefficient in water by a layer thickness of 5, 10 and 15 cm. were taken, the results of which are contained in Table III.

TABLE III

Secondary Voltages in Kv.	Tube Current in Ma.	Filters	μ Water 5 Cm.	μ Water 10 Cm	μ Water 15 Cm.	Mean Value
152.1	2	.5 mm. Cu. +1 mm. Al.	.177	.177	.177	.177
162.3	2	.5 mm. Cu. +1 mm. Al.	.165	.166	....	.166
162.3	2	.8 mm. Cu. +1 mm. Al.	.165	.164	.164	.165
179.5	2	.8 mm. Cu. +1 mm. Al.	.150	.150	.151	.150
202.1	2	1.3 mm. Cu. +1 mm. Al.	.142	.140	.141	.141
202.1	2	1.5 mm. Cu. +1 mm. Al.	.140	.141	.141	.141
202.1	3	1.5 mm. Cu. +1 mm. Al.	.141	.141	....	.141

Every single value for 5, 10 and 15 cm. of water in this table is the mean value of a great number of measurements of which the greatest error is ± 15 per cent.[1] The greatest error of the measurements of voltages, being .5 per cent lies within the error of the absorption coefficient's values for water. As these values are the same for the different layer thicknesses inside the error, we can call the filtered radiation a practical homogeneous one, which was moreover controlled by varying the layer thickness.

Tap water was used for the measurements, therefore the values of the absorption coefficient might have been falsified by dissolved minerals. But a measurement for which distilled water was taken gives the same result.

In order to determine the absorption coefficient for aluminum and to know which layer of aluminum corresponds with 1 cm. of water, we had to proceed in the following manner:

The layer thickness of aluminum was varied, until, the general conditions being unaltered, the same values were found as for the absorption coefficient of 5 and 10 cm. of water. To make sure whether the values of the absorption coefficient in aluminum might be falsified by impurities, chiefly iron, we had to analyze the aluminum chemically: there was no iron found at all. The results of the absorption

[1] The error of every μ-measurement is found in the following equation: $\left(\frac{\Delta i_1}{i_1} + \frac{\Delta i_2}{i_2}\right) \cdot \frac{1}{d \log e} = \Delta\mu$.

coefficient of aluminum are contained in Table IV.

TABLE IV

Secondary Voltages in Kv.	Tube Current in Ma.	Filters Thickness in Mm.	μ Water	μ Aluminum	Corresponding Layer of Aluminum	
					for 5 Cm. of Water, Cm.	for 10 Cm. of Water, Cm.
152.1	2	.5 Cu. +1 Al.	.177	.507	1.75	3.5
162.3	2	.5 Cu. +1 Al.	.166	.474	1.73	3.5
179.5	2	.8 Cu. +1 Al.	.150	.429	1.76	3.5
202.1	2	1.3 Cu. +1 Al.	.141	.403	1.75	3.5

In comparing the values found by earlier measurements with ours (Table V) we can see that the values of the absorption coefficient in water correspond well; while in aluminum, they diverge.

Column 6 with softer scattered rays, which are wholly absorbed in the first layers of the measuring body. If we do not sufficiently limit the beam of rays by diaphragms, we will very likely according to the grade of diaphragmization, find the most variable values, whereby we take our values as the lower limit, supposing of course that the *x*-ray bundle is sufficiently diaphragmed after passing the measuring body. Otherwise the absorption coefficient becomes smaller by softer scattered rays leaving the measuring body. By higher tensions the difference between the former measurements and ours becomes smaller. This means that the soft scattered rays are no more essentially contained in the mixture, owing to the displacement of energy—maximum of rays into the direction of shorter waves.

The value founded by Glasser[1] for water at 200 kv. differs about 30 per cent

TABLE V

Secondary Voltages		Filters Thickness in Mm.	μ Water		μ Aluminum		μ Aluminum Ordinary Arrangement of Test
With Dessauer	With Us		With Dessauer and Vierheller[1]	With Us	With Dessauer[2]	With Us	
150	152.1	.5 Cu. +1 Al.	.180	.177	.77	.507	.62
162.5	162.3	.5 Cu. +1 Al.	.166	.166	.67	.474	.59
181.5	179.5	.8 Cu. +1 Al.	.149	.150	.49	.429	.49
200	202.1	1.3 Cu. +1 Al.	.140	.141	.43	.403	.43

[1] Dessauer und Vierheller. Ueber die Zerstreuung von Röntgenstrahlen in Wasser. *Zeitschr. f. physik. u. diätet. Therap.*, Bd. 4, Heft 1.
[2] Dessauer, Grundlagen und Messmethoden. *Arch. f. Gynae.* Bd. 111, Heft 2, p. 72, Abb. 7.

It is probable that the higher values of the absorption coefficient of aluminum (Table V, Column 6) were caused by the arrangement of test—i.e., the *x*-rays were not diaphragmed enough—and that the results might have been falsified by soft scattered rays. Therefore a series of measurements with one ordinary arrangement was made, i.e., without a careful diaphragmization before entering the electroscope collimator. These results show, in comparison with the values in Table V, Column 6, a better correspondence.

Perhaps we can explain the difference between our values and those of Table V, from ours. As we suppose that in these measurements the diaphragmization was carefully made, the cause of these differences probably lies in other reasons: (1) The filters used (.75 Cu + 1 Al.), which does not give us a sufficiently homogeneous radiation for our rays' beam. (2) The different intensity distribution in the spectrum of the rays sent by the anticathode; at the same shortest wave-length the apparatus can give more softer components. The cause of the differences in output of different apparatus lies in the tension curve, in the phase between cur-

[1] Glasser, l.c.

rent and tension in secondary circuit and, if the filament is heated by alternating current, with a thin filament in the phase between the heating current and the tension at the tube. Therefore we must characterize the radiation used for deep therapy purposes not only by the shortest wave-length *or* the absorption coefficient alone, *but absolutely by both*. This is the only way to be sure that the filtered rays really contain a small part of a spectrum. Every increase of the absorption coefficient with the same tension means that there are still softer components in the mixture used. This shows in our case Figures 4 and 5, which represent spectrograms of the filtered and unfiltered radiation.

Out of the above measurements follows:

Let us extrapolate by using the formula of Richtmeyer and Kerr Grant[1] for the mass absorption coefficient of aluminum $\left(\frac{\mu}{\varsigma}\right)_{AL}$ for our limiting wave-lengths.

Formula: $\left(\frac{\mu}{\varsigma}\right)_{AL} = 14.45\lambda^3 + .15.$

This formula is proved by Richtmeyer up to a wave-length of .08 Å.U., that is our longest limiting wave-length. Table VI gives the values of $\left(\frac{\mu}{\varsigma}\right)_{AL}$ found by our measurements and calculated by the above-mentioned formula for corresponding limiting wave-lengths λ_0.

TABLE VI

λ_0 in Å.U.	$\left(\frac{\mu}{\varsigma}\right)_{AL}$ Calculated	$\left(\frac{\mu}{\varsigma}\right)_{AL}$ Measured	λ Effective
.081	.158	.187	.136
.076	.156	.175	.120
.069	.155	.159	.085
.061	.153	.149	.061

The fourth column of Table VI contains the effective wave-length calculated following Richtmeyer for $\left(\frac{\mu}{\varsigma}\right)_{AL}$ measured. From the second column, containing the mass absorption coefficient of aluminum *calculated*, one can see that the pure absorption is very small for the limiting wave-length measured. But a more important rôle, the pure absorption, takes place in the mass absorption coefficients *measured*, owing to the softer components, which take part in the practical homogeneous *x*-rays' beam together with the limiting wave-length. The striking result, that the observed mass absorption coefficient of aluminum corresponding to the shortest limiting wave-length is smaller than the calculated one, shows that the mass scattering coefficient for aluminum used by Richtmeyer is too great for this wave-length. That is because in order to get the mass scattering coefficient for aluminum the measured value of .149 must be diminished by any small factor of the pure mass absorption coefficient given by the softer components of the filtered radiation. From this we gather that this mixture of rays contains only a small part of a spectrum and that the pure absorption is no more important. All this concerns in a certain meaning, also, the values for the longer limiting wave-lengths.

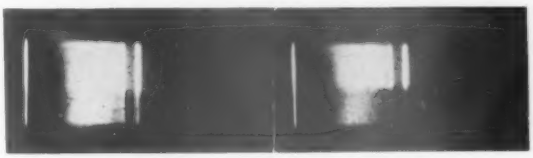

FIG. 4. Unfiltered .75 Cu. + 1 Al.

FIG. 5. Unfiltered 1.3 Cu. + 1 Al.

With hard *x*-rays and the *y* rays of radium[1] the mass absorption coefficient of water is nearly evuivalent to that of aluminum. That is because of the minimal pure absorption in both the bodies and the fairly equal scattering.

Accordingly $\frac{\left(\frac{\mu}{\varsigma}\right)AL}{\left(\frac{\mu}{\varsigma}\right)H_2O} = 1$

If we use this relation for our values, we obtain for the four values of limiting wave-length measured the value of 1.06. Therefore, by use of these radiations, the mass absorption coefficient for aluminum is practically equal to water. The same result is given in Table IV, Columns 6 and 7, where the equivalent layer thicknesses of aluminum for 5 and 10 cm. of water

[1] Richtmeyer and Kerr Grant. *Phys. Rev.*, 1920, xv, 5

[1] Glocker. *Phys. Ztschr.*, 1918, xix, 70.

are constant for all the four limiting wavelengths. By this follows: $\frac{\mu_{AL}}{\mu_{H_2O}}$ = density of aluminum = 2.7 . We found 2.8 for all the four values measured.

SUMMARY

Such an arrangement of tests is indicated for the measurements of the absorption coefficient of water and aluminum, as permits one to avoid as far as possible the errors caused by foreign influences.

It is shown that Planck-Einstein's relation gives an exact determination of the maximum voltage at the tube in the measured sphere, presupposing the authenticity of this relation.

We have measured the absorption coefficient for water and aluminum for four tensions and have shown that they are more or less determined by the scattering coefficient.

The value for the mass scattering coefficient for aluminum (.15 used by Richtmeyer) was found too high for $\lambda^0 < .08$ Å.U.

We wish to thank Professor Dr. Dessauer, Direktor des Instituts für physikalische Grundlagen der Medizin der Universität Frankfort, for the stimulus in this work, and Professor Dr. P. P. Koch, Direktor des physikalischen Institutes der Universtität Hamburg, for kindly registering the spectrograms.

THE USE OF ISODOSIS CURVES IN X-RAY THERAPY SHOWING THE INACCURACY OF THE DESSAUER CHARTS

FROM EXPERIMENTS MADE AT THE ROENTGEN DEPARTMENT OF THE HOSPITAL ZUM HEILIGEN GEIST, FRANKFORT (CHIEFS OF DEPARTMENT, DR. FRANZ GROEDEL AND DR. HEINZ LOSSEN)

BY CHARLES GOTTLIEB, M.D.

NEW YORK CITY

MOST of the larger laboratories in this country are using Dessauer's isodosis charts. While attending the recent convention of the German Roentgen Ray Society, I listened to a discussion on the reliability of these charts. There considerable doubt was expressed as to the correctness of the Dessauer measurements.

For these reasons I was especially interested in the results of measurements as presented by Dr. Holfelder at the congress, and determined to make confirmatory tests myself. I am very much indebted to Dr. Holfelder, who placed the records of his very elaborate measurements and carefully prepared results of the same at my disposal. These convinced me of the fact that the intensities within an *x*-ray cone in a water-phantom as obtained on an intensifying screen agree well with the isodosis curves of Dr. Holfelder. I wished, however, to determine through my own experiments, whether the fundamental shape of the isodosis curve remains the same, independent of the apparatus used. Through courtesy of Dr. Groedel I made the experiments in the Roentgen Laboratory of the Heiligen Geist Hospital in Frankfort.

Using the roentgendosimeter of Siemens and Halske, several *x*-ray cones were measured, readings being taken every centimeter, and the results of these measurements agreed accurately with those reported by Dr. Holfelder. It was extremely important to determine the errors due to the finite size of the ionization chamber. Holfelder, after careful consideration, has determined upon a method of correcting his curves in order to eliminate these errors (Fig. 1, center). This correction is determined through measurements of intensity within an air-phantom, in which the ionization chamber is only partially and gradually exposed to the radiation. This is accomplished by covering part of the ionization chamber with a lead plate. I have made it certain by these experiments, that when changing the position of the ionization chamber from a place of high intensity to

one of low intensity the indication is blurred to the extent as found by Holfelder. Therefore it seems to me that the corrections made on the curves of intensity, as determined by Holfelder, are well proven, not only with regard to direction, but also as to numerical value. This way we arrive at the final form of the isodosis curve (Fig. 1, right) which differs from the form of the Dessauer curves in a remarkable way. The difference is evident not only at one point, but in all characteristic points, along its entire run. This fundamental form is not influenced by the position of the diaphragm. I have made measurements with different cones of rays, during which the diaphragm was placed as close to the focus of the tube as possible. By doing this the transition at the limit of the cone into the stray field seems to be blurred only to a very slight extent. This can be figured exactly within the limits of the partial shade, which is determined geometrically by the width of the focal point of the target distance of the diaphragm from the focal point and from the water-phantom. I have made tests on several cones duplicating the conditions given by Dessauer for his charts. The measurements were made using the Neointensivreform apparatus which is Dessauer's own design, and which was calibrated by the Dessauer Institution,

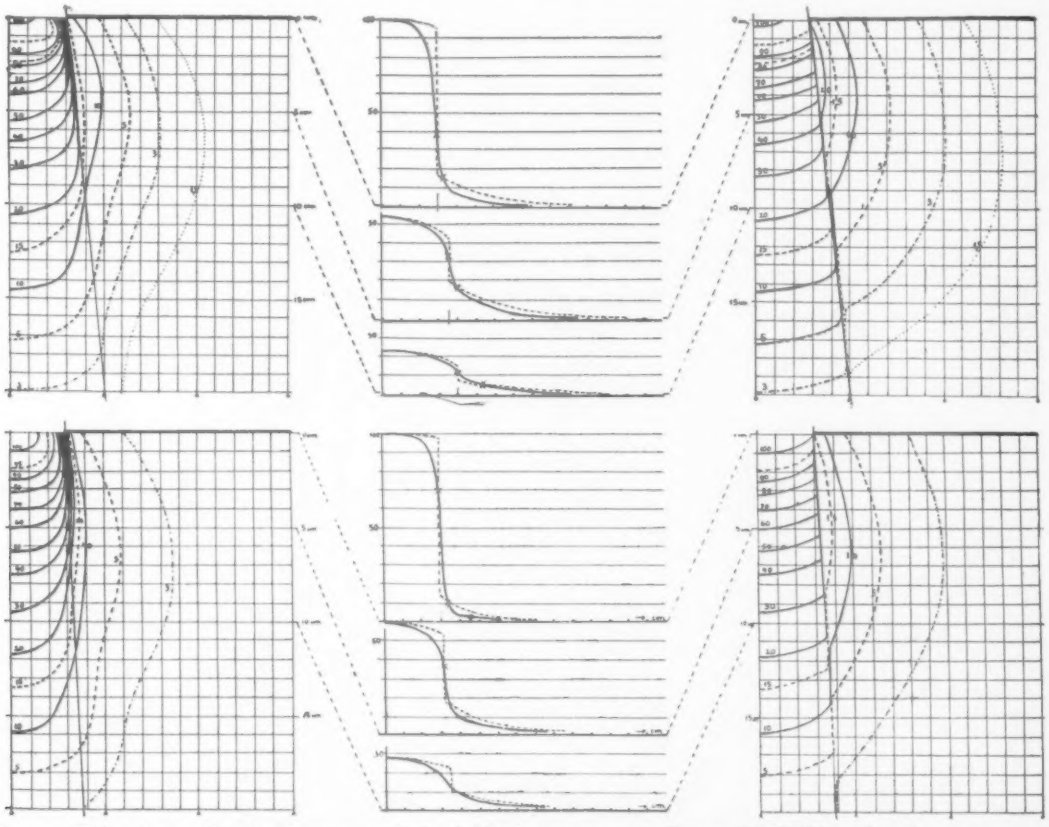

FIG. 1. This shows the development of the isodosis curves according to Holfelder, taken from a paper by Holfelder, Bornhauser and Jaloussis, in the "*Strablentherapie.*" Two *x*-ray cones are shown, taken with round diaphragms. Diameter of the diaphragm 6 cm. Diaphragm placed on surface of water. Symmetry-apparatus. Fuerstenan-Coolidge-tube. Equivalent spark-gap 45 cm., current 3 ma. Filter 0.5 cm. Cu. Half absorption value layer 13 mm. Al.

Above: *x*-ray cone with a focal distance of 30 cm. Below: *x*-ray cone with a focal distance of 70 cm. Left: direct plotting of measured values shown by curves of isodosis. In the center: plotting of measured values in horizontal planes; on the surface, at a depth of 5 cm. and at a depth of 10 cm., showing curves of intensities in these planes. Correction of these curves in order to eliminate errors due to the ionization chamber. Right: actual isodosis curves of both cones after correcting values of intensities. The sharp limitation of the primary cone and weakness of the stray-field are very apparent.

This chart is one-quarter original size, each square representing one square centimeter.

so that the values of crest (max.) voltage correspond to those of Dessauer. The results of these measurements were totally different from those of Dessauer, but agreed well with the Holfelder curves. The values of the differences must therefore be shown in an example.

The following table shows the measured intensities within an *x*-ray cone as per cents of the intensity at the surface. The figures in parenthesis are the intensities as given by Dessauer for the same

Depth, Cm.	Center Ray	2 Cm. Laterai from Center	4 Cm. Lateral from Center	6 Cm. Lateral from Center
0	100 (100)	98 (94)	12 (57)	5 (27)
2	95 (79)	90 (76)	17 (51)	9 (27)
4	75 (65)	70 (62)	23 (45)	11 (26)
6	54 (55)	51 (52)	24 (38)	12 (25)
8	39 (46)	37 (44)	20 (34)	11 (23)
10	28 (39)	27 (37)	15 (29)	9 (20)
12	20 (33)	19 (31)	12 (25)	6 (16)
14	14 (26)	14 (24)	9 (21)	4 (13)
16	9 (22)	9 (21)	5 (15)	3 (13)

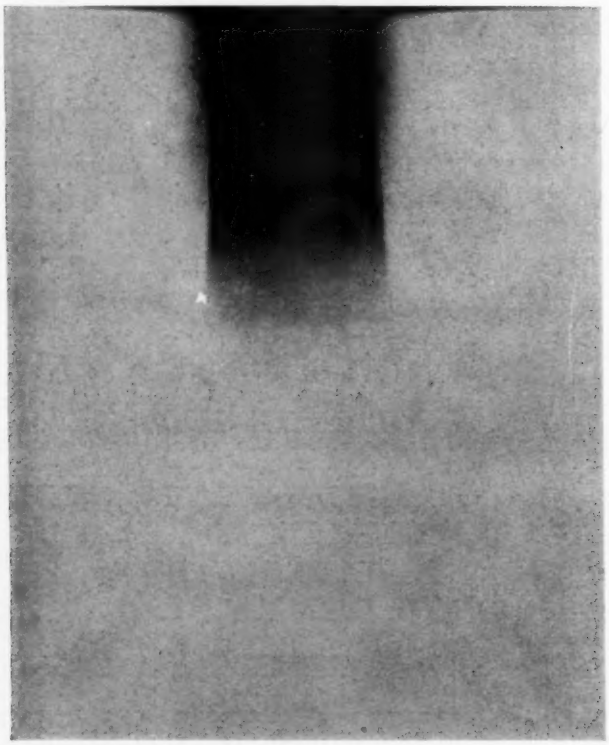

FIG. 2. This is a reproduction of a film made by me, at one-third original size. The film shows the longitudinal section through a round *x*-ray cone, taken under the same conditions as given below Figure 1. Notice the primary cone, sharply defined to a considerable depth, and the weak stray-field around the same. This film agrees perfectly with the isodosis curves of Holfelder obtained under the same conditions.

conditions. The apparatus used were Neointensivreform apparatus, Fuerstenan Coolidge tube with tungsten target, transformer voltage 200 kv. (max.), current 2 ma., filter 1.3 mm. Cu. and 1 mm. Al. Focal distance from surface 30 cm., diaphragm in the center between focal point and surface. Area of field 5.7 × 7. 6 cm., $\mu = 0.140$ (for water).

I hesitated to believe that an *x*-ray physicist as prominent as Prof. Dessauer should make such fundamental errors, and wished to assume that the differences are due to some special behavio of the Siemens dosimeter. Therefore I looked for another method, different from that of Holfelder, in order to get the results, and investigated several *x*-ray cones in water-phantoms

using a photographic film for measuring the relative intensities. The films were developed immediately after exposure. Reduced size reproductions of these films are shown in Figures 2, 3 and 4.

Figure 2 shows a narrow cone of *x*-ray, having a width of 6 cm. at a focal distance of 70 cm., using the same quality of radiation as for making the measurements. The diaphragm was close to the surface of the water in this case. One can clearly see the rather deep sharply defined cone and the weak pear-shaped stray field around the same. Figure 2 shows the same proportion with a field of 12 cm. in width and having a focal depth of 50 cm. Here we have also found a complete agreement with the iontoquantimetric results. Figure 3 shows a narrow cone having a focal distance of 80 cm., where the diaphragm was placed in the center between the surface of water and the focal point. Here the film was placed slightly at a slant to the center ray, so that there seems to be a convergence of the rays toward the depth, which, however, shows only the oblique section of the cone. In this case too, we can see a perfect agreement with the measurements, and the fundamental form is the same as in the other pictures, except that the edges seem to be slightly blurred, due to the effect of a partial shadow. When making exposures on films placed perpendicular to the center ray in the water-phantom, I received sharply defined, almost homogeneous records of the *x*-ray cone at considerable depths. This proved to me that the silver emulsion responds not only

FIG. 3. A wider cone shows the same form of distribution of intensities. The stray-field is only slightly stronger than that of a narrower cone. This film was taken with a focal distance of 50 cm. and a diaphragm of 12 cm. diameter. The conditions of tests were the same as before. This shows, too, the exact agreement with the Holfelder curves, and the strong difference from Dessauer's forms. Reduction one-third original size.

to rays of a certain direction, but is giving a true record of the intensity curve at any place in the water-phantom. After measuring the blackening of the films photometrically, at different points, we have plotted curves of iso-blackening, which are in complete agreement with the isodosis curves of Holfelder.

These different experiments conclusively prove the Dessauer charts to be fundamentally incorrect and rather unsafe for practical use. They also demonstrate that the isodosis curves of Holfelder agree well with actual conditions. The forms of the Holfelder curves differ so greatly from those of Dessauer that it appears very important to point out the most salient differences.

1. According to Dessauer, the main, primary cone is surrounded with a very wide and only slightly weaker stray-field. The primary cone, according to the Holfelder experiments, is sharply defined, and shows, even with the diaphragm placed at a considerable distance from the surface of the water, only a very narrow transitory field, which can be well explained to be due to a partial shadow. The stray field around the primary cone is of an extremely small intensity when compared to the intensity of the primary cone. This is so marked that the neglecting of the stray-field in practical use can never cause *x*-ray burns, neither can the stray-field be used for therapeutic purposes, as stated by Dessauer and his followers.

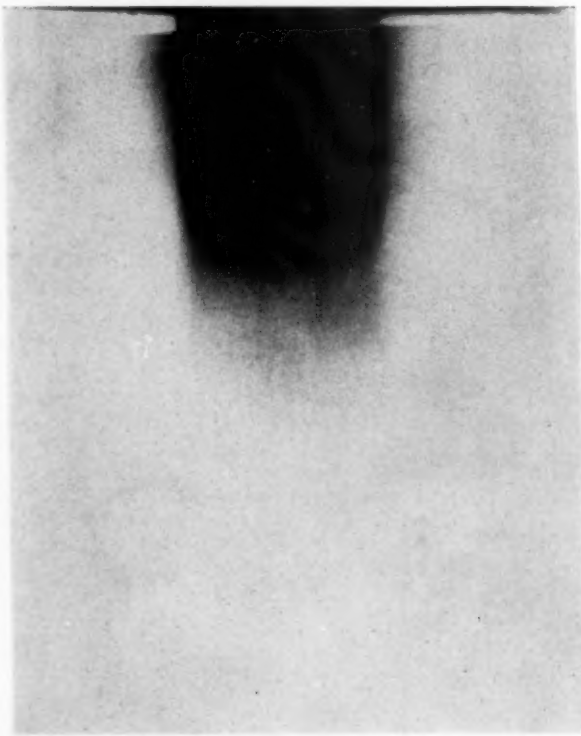

FIG. 4. Not even the position of the diaphragm changes the form of the distribution of intensity. The limit of the cone only seems to be slightly blurred. The film was taken under conditions similar to those given by Dessauer. The film was placed in the water-phantom at a slight slant, which accounts for the converging of the limits of the cone, according to the shape of a cone section. This is further proof of the fact that the primary cone is sharply limited even when the diaphragm is placed at a distance from the surface. The focal distance was 80 cm., and the diaphgram used had an opening of 3 cm. diameter, and was placed at the center between the surface of the water and the focal point of the tube.

2. The Dessauer curves show a divergence below the surface. The stray-fields of the Holfelder curves show a contraction at the surface, and a second very clear contraction at larger depths of the phantom.

3. The per cent intensity values at depths appear, according to Dessauer's data, to be too high. It was impossible to reach such values when making the tests, even with the highest available voltage. Since Dessauer made his experiments with apparatus of older types, it seems improbable that he would have had any harder rays at his disposal than the ones we used in our experiments.

4. The change of intensity toward depth follows in the Dessauer curves approximately the shape of a logarithmic curve; while the Holfelder curves and also my tests have in every case shown a very prominent hump at the beginning of the curve.

The conclusions drawn from these considerations seem to justify the title of this article.

ADVANCES MADE IN THE ROENTGEN-RAY STUDY OF GALL-BLADDER DISEASE

BY DORWIN PALMER, M.D.

PORTLAND, OREGON

THE progress which has been made in roentgen-ray interpretation, technique and apparatus has given to the medical profession an excellent instrument for the study of those cases in which infection of the gall-bladder is suspected. In the past the clinician placed little confidence in the roentgenologist's opinion regarding the gall-bladder. This was probably due to the inefficiency of the equipment and to the lack of interest shown. Previous to 1911, our attention was directed largely to the study of the gastrointestinal tract. It was while proving out the various procedures in these studies that the fundamental principles were ascertained for detecting the shadow of the gall-bladder. From this period there has been a gradual development due to the persistent efforts of the pioneer roentgenologists, Cole, Caldwell, George and Leonard, for they impressed upon us the necessity of carefully observing the salient points in technique. An article was published in 1916 by Cole and George, outlining the essential principles in examination of the gall-bladder. With minor changes we are able today to obtain from their work the maximum of soft-tissue detail. It was thought then that the detection of gall-stones was the goal to be attained. George of Boston first called our attention to the fact that the pathological gall-bladder may be shown more often than the calculi. He also stated: "Only when pathological change has taken place in the walls of the gall-bladder or in its contents can the shadows be demonstrated on the *x*-ray plates." From our experience, this statement may be questioned. These shadows are at times difficult to demonstrate; therefore, the roentgenologist should have the hearty cooperation of the clinician and the patient, and must be permitted to employ the time necessary to complete the study satisfactorily.

The preparation of the patient is of first importance. The colon should be thoroughly emptied and freed of gas which is invariably present, due to disturbed motor and possibly secretory functions. This condition is accentuated by the use of cathartics. Our routine has been to use enemata of hot soapsuds at four in the afternoon and again at bedtime on the day preceding the examination, and this is repeated upon arising the following morning. Detailed instructions should be given as to the temperature and quantity of the water, the manner in which the solution should be taken and the length of time it is to be retained. For twelve hours preceding the examination food should not be given.

Before making the films, the patient must be impressed with the importance of holding his breath and of complete muscular relaxation. The slightest movement of the diaphragm or other muscles of respiration will obliterate all soft-tissue

detail and blur the delicate ring shadows of gall-stones when present.

The roentgen-ray findings in gall-bladder disease may be classified under three headings: Direct, Indirect and Eliminative.

Direct Evidence. By this is meant the demonstration of the gall-bladder or biliary calculi on the film. Properly taken, the films include the entire area from the twelfth rib to the pelvis, and will show a clear-cut outline of the right kidney and the margin of the liver. Shadows cast by gall-stones may be confused with renal calculi, calcified lymph-nodes, suprarenal glands or enteroliths in the tip of a long, retrocecal appendix. A corset lobe of the liver and a dilated duodenum may be mistaken for the shadow of the gall-bladder itself. The gall-bladder shadow is, as a rule, sharply contrasted, with well-defined borders; especially is this true of the inner border. To differentiate the gall-bladder shadow from a corset-lobed liver or dilated duodenum often requires the correlation of the gastrointestinal report. Gall-stones are commonly identified by their typical ring-like appearance, yet many are seen which do not present this characteristic and therefore require more care in the differential study.

Indirect Evidence. This is the term applied to the changes in contour of neighboring viscera resulting from pressure or from a localized peritonitis. These changes are noted in the gastric antrum, bulb, duodenum and hepatic flexure of the colon. The antrum is always the seat of spasm, and may exhibit constant filling defects as a sequel of pericholecystitis. The duodenal bulb is flattened and occasionally so deformed that an ulcer would be suspected. The association of gastric or duodenal ulcer with chronic gall-bladder disease is not infrequent. The duodenum and hepatic flexure of the colon are frequently involved in the process and show resulting irregularities and distortions of normal contour. It should be remembered that these changes may be observed in other conditions. They are, however, very suggestive and should cause a diligent search to be made for direct evidence of cholecystitis.

Here it would seem proper to speak of the so-called "Harris membrane," described by Cole at a recent meeting of the American Roentgen Ray Society. This thin, veil-like structure passes from the lesser omentum over the antrum, cap and duodenum to the under surface of the liver and is evidenced by a blurring of the lesser curvature margin of the antrum or bulb. The etiology of the structure is by no means established. It is at times present where there is unimpeachable evidence of gall-bladder infection; and again, it is an incidental finding of the surgeon during the routine abdominal exploration.

Eliminative Evidence. This is equally as important as the positive indirect findings, since the presence of a normal gastrointestinal tract (if we may use the term) almost rules out the possibility of cholecystitis.

The diagnosis of gall-bladder disease is not limited to the demonstration of gall-stones on the films, but is made on the basis of the correlation of direct and indirect evidence. Positive cases must show, as a rule, direct evidence and, to some degree, distortion of neighboring viscera. If there are but one or two indirect points, we can do no more than suggest the possibility of gall-bladder disease and reexamine the patient at some future time. It is well to remember that the preparation of the patient and the exposure of the films is relatively a simple procedure, and failure is the result of the lack of attention to some seemingly unimportant detail.

We find in our records that, during the twelve months from October 1, 1921, to October 1, 1922, we have passed an opinion in 330 cases on either the positive or negative aspect of the gall-bladder. One hundred and thirty-one have presented direct evidence of gall-bladder infection; 28 showed stones, and 103 the shadow of the diseased viscus. All cases in the group with ten exceptions, 7.6 per cent, have shown some distortion of neighboring viscera. Fifty-three of the above cases have been submitted to surgery; cholecystectomy was done in 50, the pathological reports confirming in each the roentgen-ray findings. The remaining 3 were said

to exhibit no gross evidence of pathology. In the total cases examined, 135 gave no direct evidence of gall-bladder disease; of this number 16 have been operated upon; 1 which was reported negative showed a definite cholecystitis. A positive roentgen-ray report was rendered in 3 cases having negative gall-bladder films, because of the presence of indirect evidence. The operative findings were negative. The distortion was due to ulcer. The error here was 22.2 per cent. This gross error was due to the fact that the *x*-ray opinion was rendered wholly on indirect evidence, and it is in these cases that George[4] warns us against placing too much credence upon findings in and about the duodenum without confirmation of gall-bladder films. Forty-five cases were classified as suspicious. In these cases the films exhibited about the gall-bladder increased densities which could not be positively identified. Many showed more or less positive indirect evidence, which, together with clinical data, resulted in 12 being submitted to operation. The roentgen-ray evidence was shown to be correct in 11; 1 patient revealed no pathology of the gall-bladder. The patient referred to was screened within the past week and there still remains some doubt whether even after exploration, a true gall-bladder disease may not exist. This brings up a question which was discussed before the San Francisco City and County Medical Society, in September of this year, namely: "Are we able to state definitely by gross examination that a gall-bladder is not infected?"

Cases studied from October 1, 1921, to October, 1922:

Total positive or negative opinions	330
Operative findings reported on	81
Correct interpretations	73
Errors	8
Percentage correct	90.2
Percentage error	9.8
Percentage of gall-stones in positive cases	21.4

In conclusion we may say that the presence of direct and indirect findings is sufficient to establish the diagnosis of gall-bladder disease in at least 90 per cent of the cases, which is far in advance of our previous results.

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DIVERTICULUM FROM THE ANTERIOR SURFACE OF THE STOMACH NEAR THE CARDIO-ESOPHAGEAL JUNCTION

BY LEONARD J. RAVENEL, M.D.

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FLORENCE, SOUTH CAROLINA

THIS patient applied for *x*-ray examination on account of burning sensations in the upper gastric region with regurgitation of large quantities of mucus. Symptoms of indigestion had continued over a period of many years, during which time the appendix had been removed and the gall-bladder explored on separate occasions. The patient was a female, sixty-five years of age, and in a much enfeebled condition. *X*-ray examination showed two distinct pouches projecting from the anterior wall of the stomach at the cardiac end. These can be very clearly made out, especially in the oblique projection. The condition of the patient was such as not to permit of operative procedure.

FIG. 1. Immediately following barium meal.

FIG. 2. Oblique view, immediately after barium ingestion.

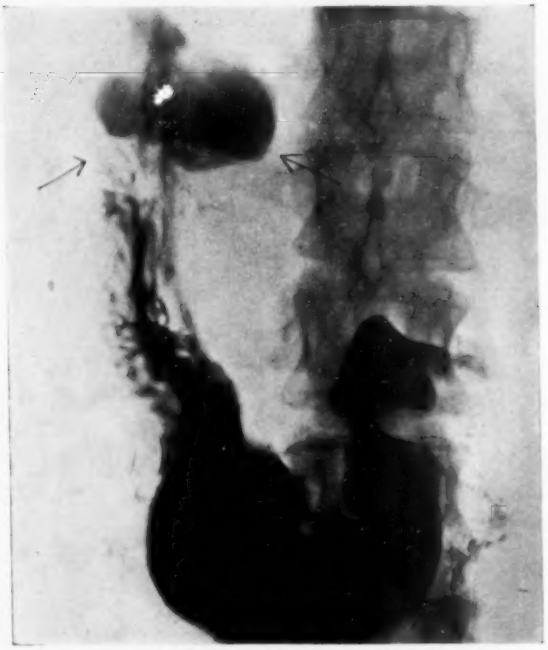

FIG. 3. Four hours after barium ingestion.

RAPIDLY DEVELOPING COMPLETE PYLORIC STENOSIS: REPORT OF A CASE

BY HAROLD SWANBERG, B.SC., M.D.

QUINCY, ILLINOIS

THE following case of complete pyloric stenosis developed so rapidly, and the clinical symptoms were so indefinite, that it was thought worthy of reporting.

REPORT OF CASE

Male, aged sixty-five, a retired physician, was referred to me by Dr. Warren F. Pearce on May 15, 1922, for roentgen examination of the stomach, the clinical diagnosis being undetermined.

The patient's past history was of little interest except that about eight years ago he was operated upon for gall-stones, and a very large stone was removed. He had always had a good appetite and had partaken of alcoholics only in moderation. His present illness dated back about five weeks, when he began to complain of gastric distress after meals. Prior to that time he was enjoying the best of health and was able to partake of practically any combination of food. His own words were: "I did not know I had a stomach." This gastric distress was characterized by a sense of fulness after meals which was rapidly becoming more pronounced. No pain was ever complained of and the patient had vomited but once since his illness had begun. There was marked loss of strength and weight. He had lost some 11 lbs. in the previous three weeks. No blood had been passed by mouth or rectum. The patient had been suffering with chronic constipation for some years. An examination of the gastric contents had been made, but unfortunately the report was lost. The findings, however, were not conclusive enough to warrant making any definite diagnosis.

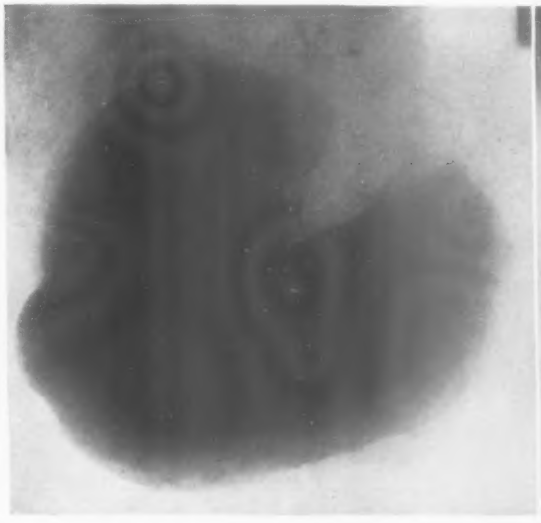

FIG. 1. Roentgenogram of stomach twenty-four hours after barium meal and three-fourths of an hour after administration of 1/50 grain atropine sulphate hypodermically, showing a complete pyloric stenosis.

FIG. 2. Same case as in Figure 1. Roentgenogram made forty-eight hours after the barium meal, showing the pyloric stenosis still complete.

The physical examination revealed a fairly well-nourished man. Cataracts were present in both eyes, rendering vision difficult. Abdominal palpation revealed a very large postoperative ventral hernia which followed the old gall-bladder operation. No abnormal masses could be palpated in the abdomen. A fluoroscopic examination of the chest was negative. Other than this the general physical examination was not remarkable. A fluoroscopic and roentgenographic examination was made of the stomach and as a result, I sent

the following report to the referring physician:

"The esophagus was negative. The stomach was greatly increased in size, with very weak peristaltic waves. Persistent palpation failed to empty the stomach. No filling defect was in evidence but there was a marked broadening of the duodenopyloric sulcus and there appears little doubt that there is a small growth encircling the pylorus. Observations at six, twenty-four and forty-eight hours showed a complete pyloric stenosis. A reexamination was made after 1/50 gr. of atropine sulphate was given hypodermically, but the pylorus failed to open, and twenty-four hours later the pyloric stenosis was still complete. Conclusion: Pyloric malignancy, resulting in complete pyloric obstruction with marked gastric dilatation. Immediate surgical relief is indicated."

Following the completion of the roentgen examination, the patient immediately left for the Mayo Clinic where he was promptly operated upon. The following personal communication, giving the postoperative findings, was received from Dr. W. J. Mayo:

"Dr. —— was operated on here May 20, when your diagnosis of pyloric malignancy with obstruction was confirmed. A posterior gastro-enterostomy was made at that time. May 26 it was necessary to go in again, when an entero-anastomosis was made. Dr. —— got on very well following this and June 24 I resected the pyloric end of the stomach for removal of the carcinoma. The growth came out very well. Dr. —— has been getting on satisfactorily and will be able to go home in about two weeks."

The patient returned home the latter part of July and showed marked clinical improvement. He continued to improve generally, gaining considerable weight. In November, symptoms appeared indicating a recurrence of the old trouble, which finally caused the patient's death on January 31, 1923.

COMMENTS

This case is interesting in that the duration of the symptoms was so short and the resulting pathology so marked. Further, the clinical symptoms were such that a diagnosis of malignancy was unsuspected, especially a complete pyloric stenosis.

The growth being located in the pyloric ring and rapidly growing, quickly produced a complete pyloric stenosis. The stomach rapidly dilated because of the obstruction. The peculiar clinical feature of the case is the failure of the patient to vomit with such a complete stenosis present.

The case well illustrates the value of the roentgen method in the early diagnosis of gastric malignancy. Carman[1] of the Mayo Clinic says. "In the Mayo Clinic, 95 per cent of gastric cancers have given distinct roentgenologic signs of their presence, a percentage not approached by any other process of examination." Every patient past middle life, with indefinite gastric symptoms that do not respond to the usual medical and dietetic treatment should be regarded as suspicious of malignancy, and a roentgenological study should be advised.

[1] Carman and Miller. The Roentgen Diagnosis of Diseases of the Alimentary Tract. Philadelphia, 1917, p. 171.

AN UNUSUAL SHADOW IN THE HEAD INTERPRETED AS CALCIFICATION IN THE LEFT LATERAL VENTRICLE

BY A. ROBERT TAFT, M.D.

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IN February, 1923, a white female twelve years and eleven months old was referred for an *x*-ray examination of the head. There is a definite history of minor epileptic attacks since the winter 1917–1918, when she had an attack of influenza. At first the attacks were quite mild, but later the convulsions increased in severity and frequency. As many as three or four attacks occured in twenty-four hours. These attacks were ushered in

by a contraction of the head to the right and a clinching of the right hand.

In September, 1920, a sore appendix was removed. This did not seem to influence the attacks. There was a suspicion of attacks during sleep, but this was not confirmed. Menstruation was ushered in in 1921, but it had no relationship to the convulsions. For the last four months attacks have been much less severe and frequent. Luminal was taken for some time with no apparent effect. The appetite is normal, and the patient sleeps well. Wassermann was negative. Health is apparently good, but the hemoglobin is only 60. Early in March the eyes became inflamed, especially the left, and vision was dull. The ophthalmologist reports an acute uveitis with spots on the cornea, etc. Mercury and potassium iodide were used followed by a decided improvement in vision with a subsidence in inflammation in two months.

X-Ray examination shows a definite shadow of increased density in the left side of the skull. This is more or less triangular in outline and was reported as a calcification of the wall of the left ventricle.

The patient was referred to Dr. Walter E. Dandy, of Baltimore, Md., who confirmed the *x*-ray opinion and thought it was the probable cause of the epilepsy. Operation was refused on account of its relationship to the speech centers.

ERRORS IN THE DIAGNOSIS OF FOREIGN BODIES IN THE AIR PASSAGES

BY PORTER P. VINSON, M.D.

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ROCHESTER, MINNESOTA

ROENTGENOLOGIC examination is one of the most valuable procedures in the diagnosis of foreign bodies in the air passages, and particularly when the foreign body is of such consistency that it is opaque to the ray. In this group of cases, however, errors may arise in the interpretation of shadows. Three cases, illustrative of this, have recently come under my observation.

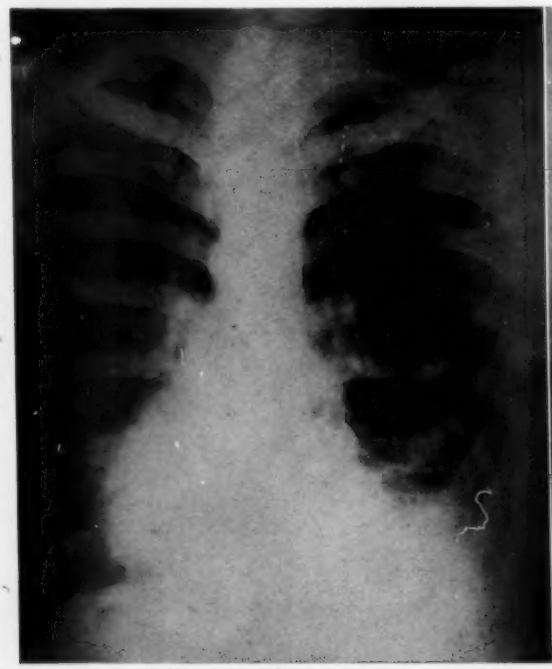

FIG. 1. (Case A424285). Roentgenogram showing a shadow in the right descending bronchus, apparently a collar button.

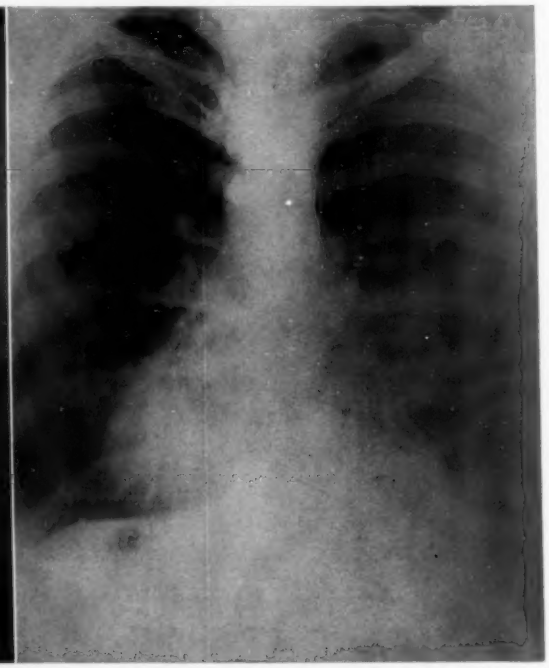

FIG. 2. (Case A424285). Roentgenogram taken after bronchoscopy and dilatation of a bronchial stricture. The shadow, supposed to be a foreign body, has disappeared.

REPORT OF CASES

Case I (A424285). Male, aged twenty-eight years. Came to the Mayo Clinic May 1, 1923. At eight years of age, he had aspirated a collar button of unknown composition. A roentgenographic examination, taken at that time, failed to reveal the foreign body. Six months after the accident, the patient had an attack of pneumonia which lasted for three weeks. This was followed by a cough with a considerable amount of purulent expectoration. Two years after the attack of pneumonia, empyema of the right side developed. Drainage was instituted and the thoracotomy incision healed after about two and a half months. From this time on, the patient continued to have three or four coughing spells each day. About an ounce of sputum, purulent in character, and at times slightly stained with blood, was expectorated at each paroxysm. The general nutrition of the patient was excellent. A roentgenographic examination had been made just before he came to the Clinic, and a diagnosis of a collar button in the right descending bronchus was made (Fig. 1).

Physical examination revealed marked clubbing of the fingers and signs of a chronic bronchiectasis at the base of the

right lung. Roentgenographic examination apparently confirmed the findings previously recorded. On May 2, 1923, bronchoscopy was performed under local anesthesia, and a cicatricial stricture without granulation tissue was located in the right descending bronchus. Forceps were introduced through the stricture into the small cavity

FIG. 3. (Case A428180). Roentgenogram showing a shadow over the left main bronchus. A diagnosis was made of a straight pin in the bronchus.

FIG. 4. (Case A428180). Roentgenogram showing no evidence of the pin in the bronchus.

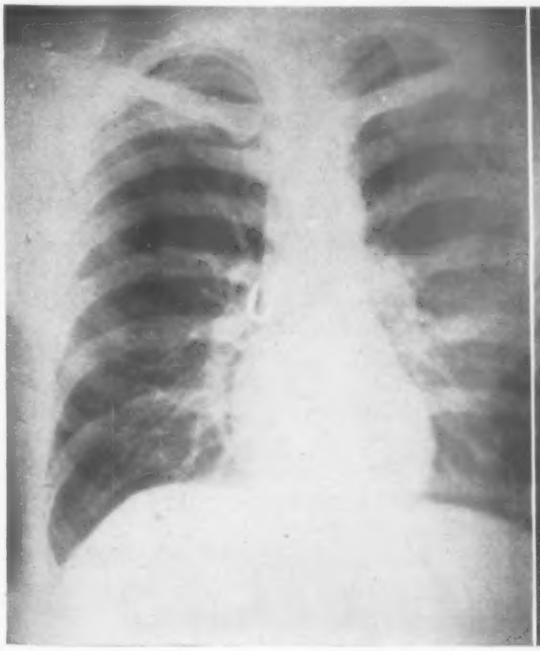

FIG. 5. (Case A430533). Roentgenogram showing a foreign body, fence staple, apparently located in the right main bronchus (Courtesy of Dr. W. A. Rush).

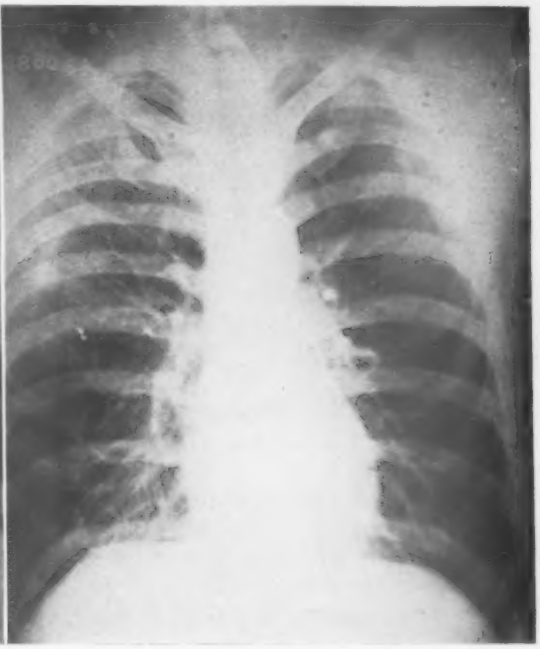

FIG. 6. (Case A430533). Roentgenogram showing no evidence of the foreign body in the bronchus.

below, but the supposed foreign body could not be grasped. The stricture was then forcibly dilated with the forceps, and the examination discontinued. On June 20, 1923, a second bronchoscopy showed that the stricture in the bronchus was of a much wider lumen than at the first examination, but the foreign body could not be located.

Repeated roentgenographic examinations have been made since the stricture

FIG. 7. (Case A430533). Roentgenogram showing fence staple in the ascending colon.

in the bronchus was first dilated, but we have been unable to demonstrate the original shadow that appeared to be the collar button (Fig. 2). It is probable that the shadow was a fibrous cast of the button that was broken up by the dilatation of the bronchial stricture. A portion or all of the button may still remain in the small abscess cavity below the stricture, and further attempts to locate it will be made. It is possible, however, that the button may have been of such composition that complete disintegration has taken place.

Case II (A428180). Female, two years of age. Brought to the Mayo Clinic, June 6, 1923, because it was believed that she had aspirated a pin one week before. The mother had seen the pin in the baby's mouth, but on her attempt to remove it, the child had strangulated and the pin disappeared. The family physician assumed that the patient had swallowed the foreign body, and instructed the mother to watch the stools. As the pin did not appear in the stools after two or three days had passed, roentgenograms of the chest were taken, and a diagnosis of a pin in the left main bronchus was made (Fig. 3). The patient was then brought to the Clinic for bronchoscopy.

Physical examination of the chest revealed nothing abnormal, and the child was free from pulmonary symptoms. Roentgenographic examination failed to reveal any foreign body (Fig. 4). On further questioning the parents, it was learned that the baby had been covered with a towel at the time of the first roentgenographic examination, and it is probable that the shadow seen in the roentgenogram was from a pin in the towel, or on the examining table. It is a peculiar coincidence that the shadow should have appeared directly over the left main bronchus. The marked movement of the pin in the roentgenogram should have suggested that the foreign body was not located in the thorax.

Case III (A430533). Male, forty-one years of age. Came to the Mayo Clinic June 23, 1923, because he had swallowed a staple four days before, while repairing a fence. A roentgenographic examination of the chest had been made the following day, and the staple was supposedly located in the right main bronchus (Fig. 5). Under the fluoroscope a stomach tube was passed beyond and far to the left of the foreign body. It was, therefore, assumed that the staple was not in the esophagus. There had been no pulmonary symptoms at any time.

By roentgenographic examination at the Clinic, the staple could not be demonstrated in the thoracic cavity, but was located in the ascending colon (Figs. 6 and 7). On the following day the foreign body was passed by rectum.

CHINESE BOUND FEET

BY JOSEPH L. HARVEY, M.D.

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THE binding of women's feet into the so-called "Golden lilies" or "Lily feet" probably originated during the first centuries A.D. There is not sufficient trustworthy evidence as to when or why the custom originated. When pressed for an answer the Chinese usually give one of two answers: "Small feet were thought beautiful," or "To keep wives from running away." In the writer's opinion the latter is probably the true explanation.

The binding usually begins when a girl is three or four years old. It consists in binding the toes under the foot and back against the heel. The result is a badly deformed foot, like a knob on the end of the leg. These women are only able to hobble very short distances.

It is now illegal to bind feet, but the practice is still maintained in some of the interior regions of China. Some of the Chinese women have unbound their feet with varying degrees of improvement in the shape and a corresponding improvement in walking ability.

FIG. 1. True bound foot. Chinese woman eighty-two years old, and 4 ft. 6 in. tall.

FIG. 2. Foot of Chinese woman forty-six years old and 4 ft. 9 in. tall. Note toes are not bound under foot as in Figure 1.

The accompanying roentgenograms should be of interest not only as curiosities but from the light they may give on the question of bone formation and its relation to tension and pressure.

FIG. 3. Anteroposterior view of Figure 1.

FIG. 4. Anteroposterior view of Figure 2.

FIG. 5. Bound foot which has been unbound for a number of years. Chinese woman forty-two years old and 4 ft., 10 in. tall.

FIG. 6. True bound foot. Chinese woman forty-four years old and 4 ft., 8 in. tall. Note toes bent backwords and bound under foot.

FIG. 7. Bound foot which has been unbound and shoe adapted. Chinese woman about forty-five years old, and 4 ft., 10 in. tall.

A SIMPLE METHOD OF IMMOBILIZING PATIENTS IN THE STANDING POSITION

BY C. HARVEY JEWETT, M.D.

Clifton Springs Sanitarium

CLIFTON SPRINGS, NEW YORK

THE following method of immobilizing patients in gastrointestinal and chest radiography is described, with the hope that it may be a distinct aid in improving technique in these examinations and also add an element of safety.

The apparatus is simple in construction and can be readily adapted to the usual upright stereoscopic plate shifts. It consists of a light canvas band stretched across behind the patient which can easily be adjusted to the height desired and made fast by a simple locking device. The whole apparatus can be constructed in a very short time; and the author has found it particularly useful with patients who are unsteady or nervous.

The accompanying diagram and illustration show the details of construction when adapted to the old style K. K. vertical stereoscopic shift. On the left side there is a vertical bar of wood set up on blocks at each end so as to allow a six-inch canvas band to be looped around it and made fast. This permits the raising or lowering of the band to the desired position.

On the right side a six-inch thin board is mounted vertically, in the center of which is a raised one-half-inch wood strip. Over this strip a grooved stick is fitted. This is fastened at the bottom with a leather hinge and can be readily held in place by an ordinary hinged hasp at the top. This hasp is bent at a right angle so as to drop down over and hold the stick in position after the canvas band has been stretched across. Raising the hasp and allowing the grooved stick to swing down is all that is required to release the patient.

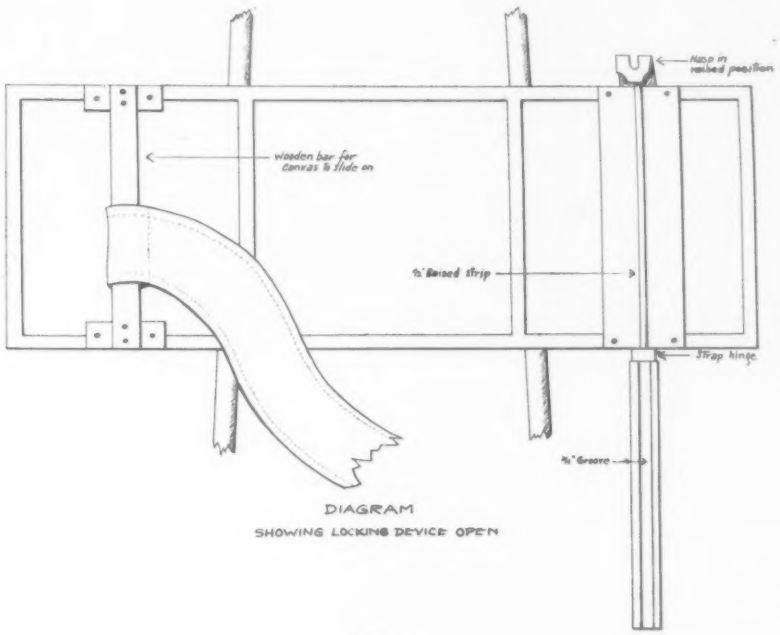

DIAGRAM
SHOWING LOCKING DEVICE OPEN

FIG. 1.

The added element of safety was recently

demonstrated in the author's experience when a patient fainted just as the exposure was made. The canvas band was sufficient to hold the patient in position and prevent him from falling back against the tube until assistance could reach him.

FIG. 2. Showing patient in chest position.

TIME-SAVING DEVICE FOR SKIN THERAPY

BY SZE-DAU TSIANG, M.D.

Peking Union Medical College

PEKING, CHINA

ALL roentgen skin therapists must have experienced considerable loss of time in setting the tube at the desired skin-target distance, and in centering the ray upon the area treated. The time-saving device here described aims to do away with both these difficulties. It consists of a piece of square wooden board about ½ cm. in thickness and the exact size of the ordinary aluminum filter. In the center of this board we make a round aperture which should be the same size as that of the tube-holder, so as to avoid possible interference with radiation. At the middle point on each of the four sides of the square board a small hole is made, and a thread passed through each to the hole opposite. The crossing point of the two threads is the center of the aperture and at the same time it indicates the central rays. At this point, a piece of thread is tied, and a small glass bead fastened to the free end of the thread. The length of this thread should correspond exactly to the desired distance from the center of the target—say 10 in. (Fig. 1). Therefore, the point touched by the bead is the center of the ray and also the desired distance from the target (Fig. 2).

FIG. 1. Wooden board with threads in position.

Take a case of ring-worm for illustration: After the scalp is marked off by Adamson's method, the board is placed in position, being slid on to the tube-holder as is done with the filters. The tube is then manipulated so that the bead barely touches the skin and the center of the area treated. Thus the central ray and the desired distance are secured. In my own experience I find I can save one minute in getting the desired distance and the central rays for each area, by using this device. Thus, in each ringworm case I save five minutes. This device is simple to make and inexpensive; it is particularly useful to roentgenologists handling big skin clinics.

FIG. 2. The device in place.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: H. M. IMBODEN, M.D.

Associate Editors: JAMES T. CASE, M.D. H. K. PANCOAST, M.D. WILLIAM DUANE, PH.D.

Publisher: PAUL B. HOEBER, NEW YORK

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Avenue, New York. Office of publication, 67-69 East 59th Street, New York.

Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

FIFTH ANNUAL MEETING EASTERN SECTION AMERICAN ROENTGEN RAY SOCIETY

CHALFONTE-HADDON HALL, ATLANTIC CITY, N. J., JANUARY 24–26, 1923.

MEETING OF EASTERN SECTION

The meeting of the Eastern Section of The American Roentgen Ray Society will be held at Haddon Hall, Atlantic City, N. J., January 24, 25 and 26, 1924.

Applications for hotel reservations should be addressed to Chalfonte-Haddon Hall. These hotels have a large number of winter guests, and it is recommended that reservations be made early.

Application for a place on the program should be addressed to Dr. Thomas A. Groover, 1621 Connecticut Ave., N. W., Washington, D. C.

It is hoped that the program for this meeting will measure up to the high standards of the past. One evening will be devoted to a Lantern Slide Exhibit. Those desiring to participate in this exhibit should advise Dr. Groover at an early date of their intention to do so, indicating the number of slides to be shown.

OFFICERS OF THE NEW YORK ROENTGEN SOCIETY

At a recent meeting of the New York Roentgen Society the following officers were elected:

President: Dr. F. M. Law, New York City.

Secretary: Dr. T. L. Le Wald, New York City.

Treasurer: Dr. John Remer, New York City.

Member of Executive Committee: Dr. C. Eastmond, Brooklyn.

REPORT OF THE LEONARD PRIZE COMMITTEE

Gentlemen:

We have received for consideration by our Committee for the Leonard Prize, eleven contributions. All are of merit. At least three or four are of sufficient merit to justify the awarding of such a prize. Unfortunately, the Society does not have the funds necessary to award $1,000 to each one of the men who have contributed these superior papers.

There are three papers of very superior merit, which are so close in value that it would be an injustice to award the entire prize to any one to the exclusion of the others. Therefore, the Committee has deemed it best to divide this price as follows:

To Prof. Wm. Duane, the first prize of $500.00, for his contribution on "Ionization Methods of Measuring *X*-Ray Dosage."

To Mr. G. Failla and Mrs. E. H. Quimby, the second prize of $300.00, for their contribution on "The Economics of Dosimetry in Radiotherapy." (From the Radium Research Laboratory of the Memorial Hospital.)

To Dr. J. W. Mavor, the third prize of $200.00, for his contribution on "Studies on the Biological Effects of the *X*-Rays."

With honorary mention of the very excellent paper by Dr. C. C. Little and Dr. H. J. Bagg. "The Occurrence of Heritable Abnormalities in Mice and Their Relations to Exposure to *X*-Rays."

George E. Pfahler, M.D.
Frederick Baetjer, M.D. } *Committee*
Geo. W Holmes, M.D.

BOOK REVIEWS

CLINICAL ROENTGENOLOGY OF DISEASES OF THE CHEST. By H. Wessler, M.D., and L. Jaches, M.D. 578 pages. Troy, N. Y., 1923.

In no country is the roentgen-ray method of diagnosis more freely used than in America. In large city hospitals probably from fifty to seventy-five per cent of patients admitted are examined in this way. Yet, until very recent years, authoritative and reasonably complete treatises in the English language on the various phases of roentgen-ray diagnosis have been lacking. The seeker after detailed information has been compelled to turn to the foreign literature, especially the German.

Clinical Roentgenology of Diseases of the Chest by Dr. H. Wessler and Dr. L. Jaches fills this long-felt need in the roentgen-ray field. The book, however, hardly requires this excuse for its existence. It is the product of years of experience of careful observers in a large hospital where good work is carefully checked up. There is no attempt at discussion of the literature or critical consideration of divergent views. On controversial points, the writers state, they have not hesitated to present their personal opinions, influenced by the best thought on these questions. Various readers will undoubtedly find points on which their personal experiences have led to opinions differing from those expressed by the authors. Such differences are stimulating and lead to profitable investigation and discussion.

For instance, in regard to the question of "peribronchial" tuberculosis, the authors' objection to the diagnosis of tuberculosis from widened and heavy bronchial shadows will be met with unqualified approval. The fact that such shadows are frequently the result of pulmonary congestion from causes other than tuberculosis can not be too strongly emphasized. However, that "peribronchial" tuberculosis does not exist in the sense of involvement of the lymphoid-cell deposits along the bronchi is by no means proven. In fact, aside from the roentgen plate, there is considerable experimental evidence that tubercle bacilli may get into the pulmonary lymphatics from the blood stream or from the air, and, floating down the lymph channels toward the hilum, be filtered out in passing through a succession of these little nodes located along the bronchi and arteries throughout the lung. In these deposits the organisms may gain a foothold and begin to proliferate, producing peribronchial tuberculosis. However, this very interesting question cannot be discussed satisfactorily here. This experimental evidence is presented by Krause,[1] whose work is very interesting in connection with the explanation of the shadows of tuberculous lesions as seen on the chest plate.

The subject of diseases of the chest is considered in ten sections, each of which, with two exceptions, deals with an anatomical subdivision of the chest, e.g., the pulmonary vessels and circulation, the trachea and bronchi, the lungs, the pleura, etc. A section on the normal lung and one on surgical diseases of the chest constitute the two exceptions. The significance of the different variations from the normal is discussed as well as the roentgen-ray manifestations of the various diseases to which the structures are liable. The text is profusely illustrated with approximately two hundred and forty reproductions of well-chosen, clear chest plates. Here and there are short abstracts of clinical histories which illustrate as aptly as do the halftones the points the authors desire to make.

In the roentgen-ray study of the chest the authors believe the fluoroscopic examination to be of vital importance. The screen, however, does not replace the plate, but rather supplements it, giving information which cannot be obtained in any other way. They feel that, with occasional exceptions, stereoscopic plates give no more information than the single plate. They stress the necessity of technical excellence and prefer a target-plate distance of four feet to the usual twenty-eight or thirty inches, as there is much less distortion of shadows. With an unscreened plate at this distance they use a gas tube with a relatively high voltage and milliamperage.

[1] KRAUSE, ALLEN K. Experimental studies on tuberculous infection. *Am. Rev. Tuberc.*, March, 1922, vii, 1.

Richard C. Cabot once remarked to his students that he believed more mistakes in diagnosis were made through errors in the detection of variations from the normal in physical examination than through errors of judgment in the interpretation of the evidence at hand. The opposite seems to be the case in the interpretation of chest plates. It is usually easier for the trained observer to detect abnormal shadows than it is for him to interpret these shadows in clinical terms. In this book such pitfalls are pointed out and the necessity of making the interpretation in the light of all the facts of the case is emphasized again and again. This correlation of clinical and roentgen-ray evidence requires close cooperation between clinician and roentgenologist, as the ideal combination of the two can rarely be found. Without this correlation roentgen-ray diagnosis will not attain its maximum accuracy and usefulness. The authors are justly enthusiastic for this method of examination which they present so well, but their enthusiasm is tempered with an intimate knowledge, born of years of experience, of its limitations, which they point out as frankly as its successes.

The worst that can be said about this book is that it contains an unusual number of typographical errors. It is a much-needed addition to roentgenological literature. Besides those who devote their entire time to this field, it will interest all medical men who have occasion to turn to the roentgen-ray method for help in the diagnosis of chest conditions, and it will be a valuable reference book for the medical student.

Ross Golden.

TRANSLATIONS & ABSTRACTS

THE BIOLOGY AND RADIATION THERAPY OF CANCER. PERTHES (Tübingen). Abstract of Proceedings of a Special Meeting of the German Roentgen Society held in conjunction with the Congress of the German Gynecologic Society at Heidelberg, May 26–27, 1923.[1]

Four conceptions enter into the roentgen cure of cancer: (1) The rays kill the carcinoma cells; (2) the rays damage the carcinoma cells, general and local resistance of the organism nullifies them; (3) the rays stimulate the connective tissue about the cancer focus to a local resistance; (4) the rays, by weak radiation of the body aside from the carcinoma, or even by radiation of the cancer focus, give rise to protective substances.

The first conception is to be rejected, for the increase of the ray does does not bring about an increased healing effect.

The third is not the present conception, for circumscribed carcinomata are destroyed by only local radiation with the minimum carcinoma dose, not, however, with small "stimulant doses" (cutaneous carcinoma and cutaneous metastases from mammary carcinoma).

As for the fourth conception, animal experiment has shown that weak radiation of the whole body raises the resistance against inoculation with mouse carcinoma (Murphy, Nakahara and others).

The second conception probably lies nearest the truth. The injury to the carcinoma cells, especially the nuclei, which shortly precedes the protective reaction of the connective tissue is histologically demonstrable in specimens excised at appropriate intervals. The aim of roentgen therapy is the greatest possible damage of the carcinoma cells and the greatest possible preservation of the resisting power of the body.

The varying sensitivity of various carcinoma forms is important. It has been demonstrated by many examples. Because of it, there can be no single carcinoma dose—only a minimum carcinoma dose (Jüngling).

How can one determine for operable surgical carcinoma the ratio of permanent cures for radiation and for operation? For cutaneous carcinoma many permanent cures have been observed, yet there are recidives and refractory cases: thus, a woman who had been cured of a cancroid under the eye developed one symmetrically placed on the other side of the face, which strong radiation did not affect. In carcinoma of the lip, radiation, especially in cases with metastases to the lymph-nodes, has given more recidives than operation. No permanent cure has been attained in a case of growth adherent to the jaw. The proportion of five-year cures from radiation of definitely operable carcinoma of the breast (Krönig's material) lags far behind the results of radical operation at the same stage. Cures of from three to seven years' duration have been observed by Haenisch, Schädel and Sudeck in carcinoma of the thyroid. The operation cannot furnish such results. A good response to roentgen radiation without subsequent cure is frequently observed in thyroid carcinoma. With the added aid of radium, isolated cases of carcinoma of the tongue and of the rectum have been observed to remain free from manifestations for more than three years, yet these are quite unusual results.

A questionnaire sent to the German and Austrian university surgical clinics has established that the directors are generally in accord with the principle that operable surgical carcinomata are to be treated by operation. Exceptions: Refusal of operation by the patient, certain cases of cutaneous carcinoma in old people, carcinoma of the thyroid. The after-radiation of cases of breast carcinoma radically operated upon is endorsed by 13 clinics, and neglected or objected to by 13. The statistics show in part a considerable decrease, in part a considerable increase of recidive following after-radiation. I myself, in agreement with Anschütz, oppose the method employed. Intensive after-radiation of extensive areas has, so far as can be recognized, only damage as its consequence, manifestly through its injurious effect upon the whole organism and its power of resistance. The clinics which present statistics showing improvement (Kiel and Rostock) radiate with small doses at long intervals. The method of exact radiation of the whole danger zone with the minimum carcinoma dose must, at the present stage of development, be shunned as hazardous. Preliminary radiation before operation has in twenty-six clinics been undertaken in only 6 special cases, e.g., by Payr for the lymphatic drainage area of lingual carcinoma with small doses, and by Schmieden for carcinoma of the rectum. The objection to intensive preoperative radiation because of diminished healing power is not established, despite current investigations (August Mayer). Inoperable carcinoma, e.g., of the lip and of the breast, can often be reduced to a definitely operable stage. Complete disappearance of inoperable carcinoma for a

[1] From a manuscript brought from Germany by Dr. Leopold Jaches.

number of years seldom follows roentgen radiation—thyroid carcinoma (Haenisch, Schädel and Sudeck up to seven years); inoperable regional lymphatic recidive after operation for breast carcinoma has been observed recidive-free up to four years by von Eiselsberg, and by Guleke up to three years! Great improvement in inoperable regional lymphatic recidive of breast carcinoma is not seldom seen. Death generally follows from distant metastases. The indications for radiation treatment of sarcoma have been clearly established by the work of Jüngling and Küttner.

Holfelder (Frankfurt-on-Main). Experience with roentgen therapy of malignant tumors in Schmieden's Clinic. For three and a half years Schmieden's Clinic has been seeking to radiate the tumor region alone with a dose just below the limit of tolerance of the most sensitive tissue in the region, with the greatest possible protection of the surrounding structures. The strict concentration of the dose makes the roentgen ray in a sense a surgical cautery. The execution of this idea has been attained with the aid of the Holfelder field-selector. The finer details of the method were developed over a course of years and are even now by no means entirely worked out. But even in the earliest days of the method the treatment of carcinoma became so much more satisfactory than it was before, that Schmieden at the Surgical Congress of 1921 and at the Frankfurt meeting of the Roentgen Therapeutic Society committed himself to an increased appreciation of the value of roentgen treatment. He stated, however, with all emphasis, that operable carcinoma always calls for operation and not for radiation. Therefore roentgen therapy in Schmieden's Clinic is definitely limited to cases of inoperable carcinoma and as an adjuvant to the radical operation, in the sense of prophylactic radiation before or after operation. It is not to be expected that in the first years the Schmieden Clinic can show any considerable percentage of cures in the hopeless inoperable cases. A thorough survey of the clinic material for the years 1919, 1920 and 1921, with an average observation time of two and a half years will show whether the estimate of the value of radiation therapy is valid or not. Yet the observation period is still too short to justify any final conclusion. Nevertheless, one can determine in what direction this is leading, and such a survey is now in order, to form a basis for one's procedure. For the judgment of the cases of cure, the most rigorous establishment of the diagnosis is necessary. Only when the histologic proof of the correctness of the diagnosis has been established in the clinic's own laboratory by Professor Klose, have the cured cases been included in the statistics. All cured cases in which the diagnosis may be ever so slightly open to doubt have been excluded. Consequently, the number of lasting cures appears considerably smaller. But in spite of this, the Schmieden Clinic has continued to affirm the value of roentgen therapy for inoperable carcinoma. Still more important is the question whether the prophylactic radiation has bettered the operative results or made them worse. The contradictory experiences of the Tübingen and Kiel clinics have cast great confusion over this matter, which is to be cleared up only by a study of the technique used. In the Schmieden Clinic during the time under consideration, prophylactic radiation was administered in 43 cases of carcinoma of the breast operated upon with an unquestioned diagnosis established histologically. Of these patients, 30, or 70 per cent, are living free from recidive after two and a half years. Individual investigation according to the grouping of Steintal indicates that the percentage of cures in Group 2 has not changed. It is hardly to be considered that within the next half year the number will fall appreciably. Thus my view is confirmed that the prophylactic after-radiation of cancer of the breast is a definitely useful adjuvant to the operative treatment. During the same time, an attempt at cure of local recidive and local or distant metastasis of cancer of the breast was made in 32 cases. Of these, 5 patients still live free from any manifestations. All these were hopeless cases which without roentgen therapy would have succumbed. Even in the fatal cases there was a temporary complete success in the majority, so that some patients appeared well up to two and a half years. The 14 per cent of cures in this hopeless material is so significant that a therapeutic attempt is worth while in every case. On the other hand, the percentage is not sufficiently high to justify following Kreuter in relying on roentgen treatment sufficiently to give up the radical operation for cancer of the breast in favor of the older less radical methods. I emphatically dissent from Kreuter's proposition.

Fifty-one confirmed cases of carcinoma of the rectum were handled during the same time. Of these, 57 per cent were inoperable. Fifteen patients, or 28 per cent, are living today, still well and recidive free. The best operation statistics show 10 to 12 per cent of three-year cures when the inoperable material is included. The combined method, in which surgery and roentgen therapy are most closely associated, shows results more than twice as good as surgery alone, for the two-and-a-half year observa-

tion period. The roentgen therapy of carcinoma of the stomach is still in the experimental stage, yet there are found cases of great improvement, though not of permanent cure, during the period under consideration. The esophageal carcinoma also still presents great difficulties, so that no permanent cure has been attained. Only the carcinoma of the thyroid shows markedly favorable prognosis. Three cases were treated, and all 3 patients still show clinical cure.

Ten cases of carcinoma of the tongue were treated, with only one cure that has lasted two and a half years. This case appeared at the beginning of treatment to be the most unfavorable of the lot.

Of 145 inoperable carcinoma exclusive of cancroid, 13, or 8.5 per cent, are well and recidive-free after two and a half years. These include a striking proportion of cases of recidive or metastasis. It seems that in general, recidive and metastasis of carcinoma react better to roentgen treatment than the primary tumor, which confirms my view that operable carcinoma, with the exception of thyroid carcinoma, should always be operated on, and that one should not compromise the prospect of surgical cure by experimenting with radiation.

As regards sarcoma of connective tissue, the results are quite otherwise. Of 14 cases in which diagnostic excision had been done, only 2 patients are living and well today. In the same period 14 patients were treated with roentgen rays without any surgical intervention, and of these, 6 are still living and 1 appears entirely cured. This difference clearly indicates the duty to warn against diagnostic excision or incomplete operation in sarcoma, since the prospect for cure is extraordinarily diminished thereby, and furthermore the diagnostic excision offers the least help in the borderline cases. Roentgen therapy with the strictest surgical forbearance furnishes, in sarcoma at least, the same duration of cure, but without mutilation, as the most radical and mutilating surgery. Therefore sarcoma cases should be only radiated and not operated upon.

In contrast to the value of the radiation therapy in the Schmieden Clinic with the technique using the Holfelder field-selector, the damage resulting has been extraordinarily little. In more than 1,000 intensive radiations with this technique, only 5 cases of roentgen injury occurred, and of these, 3 were of only a transitory nature. All 5 cases are accounted for by technical errors which it was possible to eliminate during the further development of the technique. The lasting damage was so slight that modern roentgen therapy with correct technique can be regarded as a thoroughly safe method of treatment.

Rost (Freiburg). The roentgen treatment of skin-cancer. Cancer of the skin in all its manifold forms is a true cancer, but of relatively benign character. The expression "epithelioma" instead of "cancer" should not be used, but reserved for benign epithelial tumors of the skin. From a roentgen-therapeutic standpoint, cancers of the skin are to be classified as primary and secondary. The latter arise upon the ground of previously existant diseases of the skin, or as metastases from cancer of internal organs. A conception which the author has accepted applies to the secondary cancers: the "tumor bed" (Brock) has an unfavorable outlook for cure as compared with primary skin-cancer of the same histological type. An exception to this is the cancer arising upon senile keratosis, which in this point may be regarded as equivalent to a primary growth.

The primary cancers of the skin may be usefully classified according to Darier as (1) prickle-cell, (2) basal-cell, and (3) mixed or metatypic. They are roentgen-sensitive according to the preponderating type of cell. The basal-cell growths are the most sensitive, the prickle-cell relatively little so; that is, in these cases we have the most failures. The mixed-cell occupy an intermediate position. It must be noted, however, that the histologic picture does not justify hard and fast conclusions as to the roentgen-sensitivity. In isolated cases there occur biological peculiarities which are still in part not understood, in part referable to characteristics of the surroundings of the tumor, the so-called tumor bed (for example, carcinoma terebrans: carcinoma consisting of very roentgen-sensitive basal cells, in a tumor bed of bone which reacts very poorly to the ray). With the skin-cancers go sarcoma and sarcoid, which in part respond well to the ray (with the exception of the melanosarcoma), but are rare. In regard to the treatment, the author agrees with Perthes: operative removal is indicated when this is technically possible with a view to the cosmetic effect. As contraindications to operation must be considered old age, definite constitutional diseases (diabetes, hemophilia etc.) or local disease of the involved region of the skin. Also, many patients refuse operation because of the belief common among the laity that carcinoma of the skin is relatively benign. All cases which for these various reasons are inoperable are to be radiated. Roentgen and radium rays are by and large to be regarded as equivalent: changing from one to the other can be of use in refractory cases. In respect to the method used, the author observes but a few

cardinal principles: the establishment of a carcinoma dose he regards as impossible because of the varying biological reactions of different cancers to the ray, but this does not preclude the establishment of the minimal or normal dose which is based on experience. In the Freiburg Skin Clinic the author uses for this 30 X/3 mm. Al or 40 X/4 mm. Al. These doses, not too frequently repeated as to number or length of interval, he regards as the biologic doses, since he believes that they have an adequate effect on the cancer tissue proper, without too much damage to the tumor bed which is, in respect to healing the cancer, already badly diseased. In the latter conception, the connective tissue (fibroblasts and histiocytes) and also the vascular apparatus play an important rôle. In cases which are refractory to the biologic doses, the author radiates intensively with a deliberate overdose, even producing roentgen ulceration (caustic dose). Because of the "fleckwise" effect of the rays (Rost) this method does not protect completely against relapses; but in skin cancer, these are clinically and histologically easy to recognize and to deal with. It goes without saying that the roentgen ulcer is not a pleasant consequence, but it is the lesser of two evils. The question of the value of radiation of the regional lymph-nodes (Brock) in demonstrated or suspected metastasis is not at present settled. In this connection it may be pointed out that the general condition of the patient plays a definite rôle in the cure of cancer, and that it may be so deteriorated by extensive radiation of the lymph-nodes that harm results instead of good.

The author does not venture to give statistics, since the literature is already full of incomplete examples which lack the statement of factors necessary for judgment of the subject Comparisons are therefore in no way possible. The author closes with the hope that future communications will be more explicit in this respect, so that scientific progress will not be more explicit in this respect, so that scientific progress will not be blocked by obscurity and inexactness.

Opitz (Freiburg). The biology and clinical aspects of the roentgen therapy of the gynecological cancer. The author recommends a combination of radium and roentgen treatment. Experiences with the biology of carcinoma should be assembled. Cancer even in the beginning is not a purely local disease, but an expression of a general or local disposition upon the ground of which arises the cell-growth which we call cancer. We can hope to speak of cure, therefore, only when the disposition to cancer is destroyed. At present there is no indicator to show when this state is reached. The author sees in the cure of carcinoma a *biologic* problem. Many animal experiments are necessary, but the results cannot be applied in the raw stage to man. There are great differences to be considered. The progress of treatment cannot be followed histologically in man, because removing the specimen is hazardous to the patient. The conception that a definite dosage, e.g., the carcinoma dose, is necessary to destroy the cancer focus, is wrong. The physical measurement of the ray (Kroenig) was a great step forward, but it does not solve the biologic aspect of the cancer problem. None of Kroenig's patients has remained cured who received large doses. Those of my own patients who have remained well the longest have received smaller doses. On the other hand, vigorously growing carcinoma rests were found in the connective tissue which the ray had rendered completely necrotic. The ray does not destroy the cancer cells only. Much rather, it is a battle between the parasitic invading cancer cells and the body. If the power of resistance is not sufficient, the cancer is the victor. Cancer can disappear spontaneously (Czerny). Skin carcinomata have been cured with the internal use of arsenic alone (Lassar). Detached cancer cells are overcome daily without forming metastasis in the blood and lymph-nodes. The question of the stimulant effect on remaining cancer-nests is not solved. The stimulant effect of the short waves is not recognized by some authors (Holzknecht). A regular stimulant effect has not been demonstrated on animals and plants. The Arndt-Schulz law is not applicable with certainty to the roentgen rays. The possibility of stimulation is, however, not excluded, and there may be a formative stimulation in that cell destruction incites the surrounding tissue to growth (Weigert), perhaps even also a functional stimulation. The important factor in the course of cure is the growth of the connective-tissue, but we do not know whether this is secondary or primary. In spite of their sensitivity in the living body, lymph cells outside the body are not killed, as is shown by experiments in vitro. Roentgen rays are thus no agent comparable to the chemical agents in medicines. It is certain that all cells are attacked by the roentgen rays, of course in varying degree. It is not a matter of the effect on one kind of cell, but an indirect mutual relation of the cells. Investigation of the effects upon the body after radiation indicates that the manifestations are practically the same as what we recognize as symptoms of hypertonia of the vagus, and also of the vegetative nervous system. The author has seldom found vagotonia in cancer patients. The vagus is most

active in youth, and in this period there is no disposition to cancer. Stimulation of the vagus by radiation! Also the skin reaction is of significance; marked skin reaction is to be avoided, for these cases do the worst. Large skin fields = much nerve stimulation. Also an influence on the vegetative nervous system via the endocrine glands is possible, and chemical influences are conceivable. So must the question of the effect of cholin still be investigated. Cholin set free from the radiated brain when the hypophysis is radiated? The author advances the hypothesis that the effect of radiation is a stimulation of the vegetative nervous system, the vagus preponderating.

For the practical treatment, the proposition falls under two heads:

1. Putting an end to the carcinoma focus, for which radium seems better than the roentgen ray. No overdoses, no damage to the surrounding tissues, large skin-fields, repetition of small doses.

2. Bringing up the condition of the body to a state in which it can help in the combat. For this the roentgen ray is but one of many aids employed.

The author will not speak of curing carcinoma, but only of prolonging life without suffering.

Statistics: All cases were confirmed histologically by Aschoff. From January 1, 1919, to March 31, 1922, 150 cases of carcinoma in which after-data were had.

90 cases, carcinoma of the cervix:
- 24 operable cases, of which 16 patients live, 8 are dead.
- 66 inoperable cases, of which 29 patients live, 37 are dead.

42 cases, carcinoma of the body of the uterus:
- 25 operable cases, of which 20 patients live, 5 are dead.
- 17 inoperable cases, of which 5 patients live, 12 are dead.

18 cases, carcinoma of the breast:
- 6 operable cases, of which 2 patients live, 4 are dead.
- 12 inoperable cases, of which 7 patients live, 5 are dead.

Werner (Heidelberg). The treatment of surgical cancer with radioactive substances. In the treatment of cancer, radioactive substances are employed in the form of radium or mesothorium, radium emanation or thorium X. Some forms of application have been discontinued; for example, the intravenous injection of radium or mesothorium solutions or of emanation in physiological saline, because the general effect is too strong in proportion to the on the tumor. Furthermore, the intra-arterial injection, which is very efficacious, requires uncommon anatomical conditions for its execution. Likewise the intratumoral injection of radioactive emulsions of insoluble salts is not feasible, because the costly substance is lost.

The extratumoral radiation with distant and filtered radiant bodies which are similar in effect to the *x*-ray, notwithstanding the high penetrative power of the γ ray and the relative size of the radiating surfaces which diminishes the divergence of the rays, is superior to the cone of the roentgen rays only up to a depth of about 5 cm. Even massive amounts of radium cannot show a greater effective depth. The reason for this is thought to be that as the hardness of the ray increases, the scattering increases in comparison with the absorption. There is no certain explanation.

This form of radiation can also be undertaken with glass capillary tubes filled with emanation.

The extratumoral radiation by introducing the radiant object into a preformed opening in the body requires great precaution against burns in consequence of the strong divergence of the rays. In many cases it is advisable to add supplementary doses from outside fields, since otherwise the inhomogeneity has too destructive an effect. The correct summation requires great experience.

Intratumoral radiation, which formerly was achieved by introducing radium tubes through canals made by the cautery or the trocar, can now be accomplished by the use of glass capillary tubes filled with emanation, or of steel needles containing radium.

While the dosage for external radiation depends upon the strength of the source of the radiation, the distance, the size of the radiating walls and the duration of the exposure, in intratumoral radiation there is the added factor of the volume of the tumor.

The biologic effect of the α, β, and γ rays on tumors is not markedly different, at least in histologic pictures; it only appears that the β rays produce somewhat more inflammation than the γ. Resistant tumors are better dealt with by the puncture method with ultilization of the β rays.

The so-called "stimulant effect" of weak radiation upon the tumors is not in the sense that a certain dose directly stimulates the tumor cells; it appears much more as if a fortuitous concentration of the radiation occurs with spontaneous cyclic variations of growth. Against a direct dependence upon any given dose is the circumstance that weak and strong doses quite seldom cause corresponding stimulation. When the radiation is overwhelmingly strong, the environment of the tumor can suffer more severely than the tumor itself. Then the

picture of "stimulation" is due to damage to the enveloping tissue. While with thermal stimuli with a quite definite strength of stimulus (e.g., at a critical temperature) a rapid growth occurs in even normal tissue cells with a picture of slight cell damage, there is no such relation demonstable between strength of radiation and tumor-cell reaction.

Acute burns as well as delayed effects (among them the development of cardinoma upon the altered skin) are as great risks with external radiation with radioactive substances as with roentgen radiation, only thelesser extent of the injury makes the prognosis for recovery better. Especially unpleasant are radium burns in preformed cavities (perforation, hemorrhage, etc.).

Preliminary exposure before operations is to be recommended only where it is sought to shrink a locally inoperable tumor, or to mobilize one. After large doses the wound heals much less readily, though not in the same degree, in all parts of the body. Medium doses are better borne, and are often used for this purpose. Where healing by first intention is absolutely necessary, the preliminary radiation is not recommended.

After-radiation following operations is a question only under certain conditions, for usually roentgen radiation is employed on account of the larger fields covered. After extirpation of small tumors or after removal of such from preformed openings (upper jaw, pharynx, etc.) after-radiation with radium is in order. In bone-cavities it is prone to lead to wall necrosis, which however with good drainage terminates harmlessly. The only localities in which so far the application of radioactive substances has been fruitful are as follows: sarcomata of the skull, mostly periosteal or of myelogenous origin, are favorably influenced as a rule. The effect is similar to that of roentgen rays. Of the intracranial tumors, sarcomata of the dura and tumors of the hypophysis have been made to vanish, with a cure period of several years; in general, however, the roentgen treatment is the better. The carcinomata and more especially the sarcomata of the nasopharynx are not infrequently favorably influenced locally, yet they seldom heal completely. In retrobulbar tumors, especially gliomata and sarcomata, the extratumoral radiation is very effective, even if it seldom leads to a complete cure, and is less dangerous than the intratumoral radiation if one seeks to spare the eye. Doses exceeding the single skin dose are to be avoided.

In tonsillar tumors, especially sarcomata, the results are favorable with either intra- or extra-tumoral radiation, even after conservative operation. In tumors of the upper jaw, operation is to be recommended without qualification. Here the treatment of recidive, with cross-fire from the oral cavity and cheek externally, gives better results than the primary radiation. Radiogenic bone-necrosis is recovered from without harm.

In carcinoma of the mucous membrane of the cheek, radiation is worth just about as much as operation. Permanent cures are rare, and refractory cases of the extremest sort occur.

Although carcinoma of the tongue has been treated with apparently permanent cure, operation is very much to be preferred. After-management of recidive is successful only in a few cases. The puncture method seems better than the extratumoral radiation.

Sarcoma of the floor of the mouth reacts favorably. Complete regressions have been observed for two to three years. Carcinoma of this region reacts badly.

Circumscribed sarcoma of the lower jaw is treated as well by radiation as by operation, especially in the young.

Sarcoma of the parotid is accessible to extensive and rapid influence by treatment with both intra- and extra-tumoral radiation. Carcinoma reacts exceedingly poorly. Mixed tumors react relatively well in their sarcomatous portion, but complete regression occurs seldom.

In carcinoma of the larynx there are four methods available: intralaryngeal extratumoral, extralaryngeal extratumoral, and intratumoral with or without laying the tumor free. The results with the last two methods are the best. If the tumor is not laid free, the needle-puncture method is used; otherwise, the introduction of emanation tubes. Damage to the interior of the larynx is to be avoided. According to the newest American statistics, 7 out of 20 operable cancers showed complete regression over from one to many years; the results were considerably worse with extensive carcinoma, showing a few cures lasting several years.

Struma maligna has been shown to respond especially favorably. Circumscribed nodules are best suited to extratumoral radiation, the diffuse forms better for roentgen therapy. Even multiple metastases in the neighborhood and in the mediastinum can be made to vanish. The majority of other tumors of the neck, with the exception of branchiogenic carcinoma, are better treated by roentgen radiation, since in this location the extratumoral radiation can easily cause distant damage by tangential rays. The resistant tumors are therefore reserved for radium treatment.

Although a few cases of carcinoma of the breast have remained apparently cured for a number of years after radium treatment and a permanent cure appears to be possible, the treatment of choice is indubitably surgical. Inoperable and recidiv-tumors when they are large and flat are better treated with the roentgen rays; when they are circumscribed infiltrations they are better treated with radium either by cross-fire of intratumorally. Temporary extensive improvement is frequent, complete permanent cure quite rare.

Of the intrathoracic tumors only the esophageal carcinoma is suited to radium treatment. The introduction of tubes with the esophagoscope, or on an endless thread with the aid of a gastric fistula and under fluoroscopic control is the best. A few apparent cures have lasted more than two years; most cases show improvement only for a year or a year and a half. There are many complete failures. The cases in which diagnostic excision was performed have done more badly than the others.

Of the intra-abdominal tumors, only the sarcomata of children have been favorably influenced by radium. The reason lies in the lack of effective range of radiation, which prevents an adequate dose reaching any but an especially sensitive growth.

Somewhat similar has been the experience with the renal and suprarenal tumors, which in children quickly regress under extratumoral radiation.

The carcinoma of the urinary bladder, which formerly was treated with intravesical radium application with transitory results, seems to react better to the puncture-introduction of radium. The end-results are still not definitely established.

Likewise in prostatic and rectal carcinomata the puncture method is to be regarded as a step forward, even if, because of its limited local effect, it cannot often produce permanent cure. The sparing of the rectal mucous membrane is of great importance.

For sarcoma of the extremities, radium cross-fire is as valuable in many cases as roentgen treatment. The indications are: (1) A desire to avoid amputation until at least a test radiation has been given, which may because of its favorable effect make the amputation unnecessary; (2) constitutional disease which renders the patient a poor risk; (3) inoperability of the tumor or refusal of operation.

The advantage of treatment with radioactive substances is their great adaptability, in their various application forms, to anatomical conditions.

(*To be concluded in December issue*)

SCHALL, W. E. A new *x*-ray spectrometer. *J. Röntg. Soc.*, Apr., 1923, xix, 50.

The author refers to a spectrometer recently described by Staunig, March and Fritz, combining, as it were, the methods of Laue and Braggs. The *x*-rays are passed through a crystal, and after reflection has taken place on the internal atomic planes of the crystal, the reflected beam is examined on a fluorescent screen.

In applying the spectroscope to medical *x*-ray practice, the crystal is rotated slowly. It is found at a point to the right or left of the central ray—according to the position of the crystal—the reflected beam first flashes up quite suddenly. Further rotation of the crystal moves the image produced by the reflected beam on the scale away from the central point till it eventually dies out. When the image first apears it is faint, but as the crystal is rotated, there is a rapid increase in intensity to a maximum, and then a fading away. Thus there passes before the eyes on the fluorescent screen the spectrum of the particular *x*-radiation, which is being obtained from the tube. It differs from the spectrum of visible light only in that the whole of it cannot be seen at once, but only the part corresponding to the particular wave-length which the position of the crystal at a particular moment picks out. And moreover, the various wave-lengths in the spectrum are distinguished only by the angle of incidence and reflection and not by various colors, as in the case of visible light.

The point at which the spectrum suddenly flashes up is that of the shortest wave-length which is present in the heterogeneous beam employed. This is called λ_0, and it can be measured with considerable accuracy, to the nearest 0.005 Ångstrom unit. And having measured this λ_0, one has learned very much about the radiation.

In the first place, Duane and Hunt, in examining continuous spectra from *x*-ray tubes, came to the conclusion that the minimum wave-length varies inversely with the voltage applied to the tube. And they enunciated the law that the product of λ_0 in Ångstrom units and the impressed voltage is a constant, namely 12,358. This was subsequently found to agree with results obtained from the law of Planck and Einstein, based on the quantum theory. The measurement of λ_0, therefore, gives an absolute value for the voltage applied to the tube.

As regards roentgenography, tables have been drawn up showing which wave-length of radiation is most suitable for various cases which are encountered, and these tables are

being enlarged as time goes on and experience is gained.

As regards radiotherapy, the advantage is greater still. It is possible now to state definitely what wave-length, that is to say, what quality of radiation is employed on a case, and so to compare the results more accurately with other cases. And more especially, it is possible to repeat a dose with very much greater certainty than hitherto.

WEBSTER, J. H. The clinical results of the treatment of malignant disease. *Lancet*, Feb. 24, 1923, p. 373.

The author summarizes the present-day opinion of the value of *x*-ray treatment in malignant disease.

1. With few exceptions, every operable carcinoma should be operated on, with prophylactic postoperative radiation added. 2. In addition to postoperative radiation, a single intensive radiation before operation is coming to be considered important. 3. Practically all inoperable carcinomata and all inoperable recurrences should be radiated. This gives in many cases clinical cure; in others it results in operability, often less bleeding, irritation and pain, as well as limitation of further metastasis. 4. Facial carcinomata, even when operable, can well be treated exclusively by radiation for cosmetic reasons. 5. Sarcomata, as a rule, should only be radiated, certainly in all cases in which operation would cause considerable bodily mutilation. Any increase in size of the tumor after an efficient radiation should not be considered proof of failure to respond: it is usually only temporary. (Schmieden here gives five essential technical requirements.) 11. In the treatment of malignant tumors, along the whole line, *x*-ray work has become superior to radium treatment. 12. The time has not yet come when comparative statistics can show the value of operation or radiation.

The author also outlines at least six different lines of advance in the evolution of radiation treatment, as follows:

1. In the engineering and electrical workshop, improvement of apparatus in power and reliability. 2. In the physical laboratory much remains to be done with measurements of dosage, standardization, calculation of scattered radiation and absorption in animal tissues (this is specially necessary for radium dosage, as Guilleminot and others have noted); the physical side of biological radiation effects —for example, ionization and osmotic changes in cells and fluids—requires much research. 3. In the postmortem room and the pathological laboratory, more statistical and experimental work; apart from immunity and gross animal tumor work, the histological tissue reactions to radiation, as Ewing says, seem to require the combined genius of a Waldeyer, a Weigert, and a Virchow to elucidate them; here new methods like vital staining may be of use; and there is a very wide range for biochemical investigation as to the radiation effects on basal metabolism, etc., and as to the rôle of the cell-lipoids and cell-decay products, etc. 4. Clinical technique is a most important branch requiring much further working out—for example, anatomical technique of radiation applications to different sites of the body on such lines as Holfelder's in Schmieden's clinic, by sectional scaled sheets and models and graphical representation of radiation fields. For the last year I have used scaled drawings in almost every case, and regard this as essential. Auxiliary technique such as diathermy, ionization, radiation stimulation (ductless gland) dosage, or general minimal repeated radiation or other means for stimulating the patients' immunity requires much further research. 5. In relation to surgery enough has already been said as to the necessity and value of team-work, and the best results have been shown so far in several important spheres to have been the result of close cooperation between surgeon and radiologist. Much still has to be learned as to the value of pre- or postoperative radiation, or both, and when the raying should be given in relation to the operation, and in what types and sites of lesion one or other or a combined method is best for the patient. 6. Finally, auxiliary medical measures require much further investigation; though about 100 substances have already been tried, still in the sphere, some day, may be discovered what may displace both surgery and radiation in the treatment of malignant disease. At present the general management of the cancer patient is too often neglected; open air, exercise, diet are not unimportant in recovery, and the rôle of hematinics, colloid, protein, and animal extract injections or transfusion, and of drugs such as arsenic, iodide, etc., is little understood as yet.

SOMMER. J. Operation for subphrenic abscess. *Zentralbl. f. Chir.*, Feb. 10, 1923, p. 215.

J. Sommer describes a method of deciding by *x*-rays whether a subphrenic abscess is operable by the subcostal route or whether it will be necessary to cross the pleural cavity. The subcostal route is preferable, provided the abscess cavity extends downward sufficiently to allow of drainage without opening the general peritoneal cavity. This point is determined by laying the patient on the sound side, with the

pelvis slightly raised, and screening anteroposteriorly. In the case of gas-containing abscess the gas will rise to the highest part of the cavity—that is, toward the ribs and costal margin—and the extent of the cavity in that direction can be mapped out, assisted by slight alterations in the position of the patient. In the case of an abscess not containing gas, it is a simple matter to inject a little air with an exploring syringe, after withdrawing a corresponding amount of the fluid contents. In the case of a gas-free subphrenic abscess associated with a large pleural effusion the problem of diagnosis is difficult. If the exploring syringe strikes different fluids at different levels, subphrenic abscess may be presumed with fair certainty. If this fails, however, a quantity of the pleural effusion may be withdrawn and replaced by air; with the patient in the lateral position the remainder of the pleural fluid will then fall away from the diaphragm, and the position and mobility of the latter may be observed. If any doubt still remains, an exploratory puncture may then be made, under the guidance of the *x*-ray screen.

FRÄNKEL. Combination of tuberculosis with primary or roentgen carcinoma of the breast. *Strablentberapie*, xii, *595*.

Female, sixty-four years old. Left-sided tuberculosis of the breast, histologically demonstrated. After operation, a fistula occurred, was treated with *x*-rays and cured. Two months later there was a growth the size of a hen's egg in the right breast. Six *x*-ray treatments were given with a 2 mm. aluminum filter; complete disappearance of the tumor. Two years later a large tumor, the size of a man's fist, developed in the right breast. Repeated *x*-ray treatments in the course of the next year. The tumor was reduced to a small remnant after each course of treatment, and the patient did not come for further treatment until it increased in size again. In addition, tuberculous processes in the neck and chin were irradiated. In 1920, four years after the appearance of the first growth in the right breast, it began to grow again, was removed by operation, and proved to be carcinoma. The author considers the possibility of the development of carcinoma on the basis of tuberculosis under the influence of roentgen radiation.

DAWSON, TURNER. The use of radium in the treatment of disease. *Brit. M. J.*, Mar. 17, 1923, p. 464.

Of malignant affections the author finds very amenable to radium treatment rodent ulcers, epitheliomata, lymphosarcomata, spindle-celled sarcomata, malignant disease of the cervix, sarcomata of the nasal passages; and of the non-malignant affections, exophthalmic goiter, early keloids, and certain nevi. They might be termed first-class subjects, because they admit, under favorable conditions, of actual cure. Under second-class subjects—meaning thereby conditions which may be ameliorated but in which a cure can rarely be expected—might be placed carcinomata, lymphadenomata, and splenomedullary leucemia.

Turner has now treated upwards of 200 cases of exophthalmic goiter by means of radium therapy. With two exceptions all derived more or less benefit, both in their general conditions and special symptoms.

In the treatment of exophthalmic goiter and of nevi in children by radiation, radium has the following advantages as compared with the *x*-rays: (1) Absolutely constant emission of rays, and therefore exact dosage possible. (2) Greater penetration of its rays, so that the deeper parts are reached. (3) Saving of time, as the radiation is maintained night and day until the necessary dose has been administered. (4) No noisy, exciting apparatus, so that the treatment can be applied at the bedside without in any way alarming or disturbing the patient.

LEVY-DORN AND WEINSTEIN. The effect of *x*-ray treatment on blood pressure. *Fortschr. a. d. Geb. d. Roentgenstrahlen*, xxviii, Hft. 2.

According to the authors' experiments, it is evident that roentgen radiation in the smaller and medium doses may cause temporary slight changes in the blood, and that these changes are more marked if the region of the 11th thoracic vertebra—the suprarenals—is irradiated. A definite rule in regard to relation of the intensity of the changes to the strength of the dose cannot yet be formulated; the stimulation dose for the suprarenals is not determined. In order to exclude psychic influences in the first examination, apparent radiation was first given.

SANVENERO, F. Sarcoma successfully treated by *x*-rays. *Riforma med.*, No. 10, p. 221.

Sanvenero reports a case of sarcoma of the chest that had twice recurred, treated by twelve roentgen-ray treatments of five minutes each, and entirely cured. No information in regard to milliamperage or dosage is given, except that an aluminum filter was always used and the tubes (Müller water-cooled tubes) were 15 cm. distant from the skin.

WACHTER. The influence of roentgen rays on gastric secretion. *Strablentberapie*, xii, *556*.

The acid values of the stomach seem to be susceptible to the action of the *x*-rays. A distinct generally applicable rule cannot be form-

ulated. In a general way, however, the normal acid values are diminished through a prolonged radiation. On the other hand, an acidity may be removed through a stimulating radiation. The technique of the examination is as follows: Test breakfast, followed on two successive days respectively, by one-fourth erythema dose; another test breakfast, again followed on two successive days by one-fourth erythema dose; then again a test breakfast. Filter 3 mm. aluminum.

HUDSON, B., and SUTTON, P. G. *X*-ray examination of the chest. *Lancet*, Mar. 17, 1923, p. 535.

The authors summarize their remarks by stating that an inexpert opinion on a roentgenogram is vaueless and often misleading; that many normal chests show distinct mottling and root shadows which need not be referable to tuberculosis. Fluoroscopic and plate examination are essential before undertaking and during the continuance of artificial pneumothorax.

ZUMPE, H. Changes in the blood picture and its value in the prognosis of the roentgen therapy of cancer. *Strablentherapie*, xii, 696.

Zumpe determined the hemoglobin color index, number of erythrocytes, basophilic and eosinophilic cells. With respect to the leucocytes, he adhered to the classification of Schilling into myelocytes, juveniles, rod-nuclear and segment nuclear cells. In addition the lymphocytes and large mononuclears were ascertained. Under normal conditions, the blood should contain from 58 to 66 per cent of segment nuclear and from 3 to 5 per cent of rod-nuclear leucocytes, the latter as transition forms between the myelocytes and juveniles on the one hand, and the segment nuclear cells on the other. A "displacement to the left," in the sense of an increase of juvenile forms, points to a regenerative process.

In the estimate of the blood picture, the patient's constitution and the type of disease must be taken into extensive consideration, as well as associated diseases, modality and site of the radiation. In malignant tumors, the change of the blood picture goes parallel in a general way with the gravity of the disease. A "displacement to the left" takes place in typical fashion as in an immediate sequel of the radiation, through a stimulating effect upon the blood-forming organs, furthermore as a repair-process in the leucopenia which is produced by all radiations. A return to the normal standard of the blood picture may be credited with a certain value for the prognosis.

PARTSCH, FRITZ. Indications for pneumoperitoneum. *Zentralbl. f. Chir.*, June 24, 1922, p. 905.

Attention is called to a new indication of pneumoperitoneum, possessing surgical importance, namely, its employment before the extirpation of splenic tumors. No matter for what indications an enlarged spleen is to be operated upon, the question of operability depends upon the demonstration of eventual more or less solid and extrinsic adhesions of the splenic capsule to its surroundings, especially the diaphragm and the lateral abdominal wall. In these cases, palpation and ordinary roentgen transillumination are apt to fail, pneumoperitoneum alone providing accurate information as to the extent of adhesions, so that its employment is urgently recommended before every extirpation of the spleen. In the course of the last six months, Partsch had three times occasion to perform a splenectomy, after application of pneumoperitoneum, and transillumination, on the day preceding the operation. These cases concerned an echinococcus cyst of the spleen; splenomegaly in portal venous thrombosis, and in hemolytic icterus, respectively. The lesson taught by these cases was that pneumoperitoneum, without precisely replacing an exploratory laparotomy, may provide sufficient indications, before the performance of splenectomy, of the difficulties to be expected at the operation. The prognosis of the intervention is clearly elucidated, as in the third case where no adhesions were demonstrable in pneumoperitoneum and a favorable prognosis could be rendered. In other cases, where extensive surface adhesions are demonstrable, the surgeon may see sufficient reason to abandon laparotomy. Pneumoperitoneum as a routine procedure before splenectomy will reduce the number of cases in which the operation has to be stopped on account of undetachable adhesions.

NURNBERGER, L. *X*-raying of the spleen to control uterine bleeding. *Zentralbl. f. Gynäk.*, Jan. 6, 1923.

Of 25 patients suffering from uterine hemorrhage, 18 were permanently relieved by the treatment. In 2 cases amenorrhea persisted for a considerable period, which makes it appear that secondary effects are exerted upon the ovary (probably direct radiation?). Eight of the patients had adnexal tumors, 10, so-called functional ovarian hemorrhages. In several cases the bleeding stopped within one-half hour of the treatment. In the majority cessation took place on the third day, which is the day on which the coagulant factor reaches its highest intensity.

Patients were radiated while lying on the side, the field being 6 × 8 cm. The apparatus used was the "Symmetry" Coolidge tube, 190 kv., filter 0.5 zinc and 3.0 aluminum, at a distance of 23 cm. The first treatment consisted of ¼ H. E. D. If, as rarely happened, no effect was obtained, three days later an additional ⅔ H. E. D. was given.

BIRCH-HIRSCHFELD. The question of damage to the eyes from roentgen irradiation. *Strahlentherapie*, xii, 565.

Report of 2 cases: (1) Repeated intensive multiple-fields radiation of the left eye, in a patient twenty-eight years of age, for sarcoma of the choroid. Strong reaction, blepharitis and conjunctivitis, pains, loss of eyelashes. The cornea looked like frosted glass covered with fine sand grains. The vessels of the sclera presented dilatations and constrictions. After the fourth radiation, a small ulcer appeared in the corner. The inflammatory manifestations subsided again. (2) Man of sixty-one years had been radiated very intensively five times within one year, on account of a small cancroid of the upper lid (elsewhere, no detailed statements). Every radiation was followed by fever, headaches and reddening of the eyes. Vision was gradually lost down to total blindness. Findings: Transparent swelling of conjunctiva, greatly congested and twisted tortuous vessels. This swollen tissue extended in part over the cornea. The cornea itself was entirely opaque, with a dull uneven surface. The iris was barely visible. The blind eye was removed on account of extremely severe pains. Examination revealed glaucoma. The corneal epithelium, which normally consists of cylindrical basal cells, was for the most part transformed into pavement epithelium. The entire cornea was interspersed with infiltration foci. Grave vascular changes, extending to the retinal vessels This observation indicates the need of caution in radiations in the domain of the eye-ball.

MOSENTHAL, A. Roentgen appearances of pyonephrosis. *Zeitschr. f. Urol.* 1921, xv, Hft. 11.

As pointed out by Israel, a distinction is made in pyonephrosis between: (1) primary hydronephrosis with secondary infection; (2) primarily inflammatory processes of the kidney or the ureter, with secondary retention of the renal products; (3) tuberculous pyonephrosis, or pyonephrosis originating through renal infection in tuberculosis, respectively. From the incipient stage on, these three groups present such entirely different pictures that pyelography absolutely enables us to discover from the *x*-ray pictures, even at the beginning of the pathological process, not only the existing dilatation of the renal cavities, but also to recognize almost without exception the etiological factor for the origin of the pyonephrosis. Lithium iodide, as recommended by Joseph, probably furnishes the best and sharpest contrasts.

RÉVÉSZ. A case of renal calculi mistaken for echinococcus cyst. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, Hft. 5.

In the case of a medical student, twenty years of age, the *x*-ray picture showed in the place of the kidneys two large, nearly circular, sharply outlined shadow formations, with a diameter of 8 cm. on the plate. Echinococcus was assumed, but the operation showed the condition to be due to calculi, the size of a nut to that of an apple, in the remarkably large and distended renal pelvis; although the patient never suffered from renal colic. The contact surfaces of the calculi were very smooth, and besides the two large stones, there were three smaller ones. The calculi weighed together 225 g. The circumference of the largest stone was 20 cm.

BLAISDELL, FRANK E., SR. Fracture of the tibial spine. *Arch. Surg.*, Nov. 1922, v, 561.

This article is an experimental study based on cadaver work. There is not much in the textbooks on fractures of the tibial spine except when occurring as a complication of a more serious injury to the knee.

This article gives a careful study of the anatomy of the parts and details experiments.

In the course of his article the author gives the following definition of sprain and fracture:

1. A strain is a stretching of the soft parts with a minimum amount of damage. It is not recognizable macroscopically, causing subjective symptoms.

2. A sprain is a rupture of the soft parts—ligaments or fasciae; recognizable by ecchymosis, loss of function and pain, the symptoms of which are both subjective and objective.

3. A sprain-fracture is, in the milder form, recognizable only by roentgen-ray examination; in the severer form it is recognized as a part of the pathology of dislocation.

In the milder form the crucial ligaments are involved, in combination with a strain or perhaps a sprain of the collateral ligaments, or injury to the menisci; in the latter both the collateral and crucial ligaments are involved, with different degrees of dislocation.

WETZEL. Damage from irradiation treatment with and without changes in the skin. *Strahlentherapie*, xii, 585.

Report of two cases: (1) Roentgen ulcer in the larynx after repeated radiation of the neck

from several sides on account of tuberculous lymphoma. Ten radiations, with the exception of the last session, ½ unit dose per field, repectively; at last 1 unit dose, distributed over nine months. Tracheotomy. Death. (2) Necrosis of the larger portion of the left lobe of the liver, after radiation of an inoperable gastric carcinoma in a cachetic woman. Perforation of the stomach occurred as a sequel to the second radiation with three fields from in front (9:9 and 6:8 respectively) and two fields by way of the back with 3 mm. aluminum filter. Peritonitis and death. Autopsy findings: Carcinoma in course of marked retrogression. In the opinion of the pathologists, the disintegration of the stomach at the anterior wall took place independently of the cancer. The necrosis of the left lobe of the liver corresponded to the realm of action of the crossed fire. The occurence of heaptic necrossi by way of five concentric small fields presumably constitutes a unique observation in literature.

SEITZ, ERNST, AND RIEDER, WILHELM. An apparatus for the exact determination of the central ray in the roentgen treatment of rectal carcinoma. *Zentralbl. f. Chir.*, July 29, 1922 p. 1098.

The radiation of rectal cancer in the Frankfort clinics is usually carried out by way of five ports of entry (two abdominal fields, two sacral fields and one perineal field). The abdominal fields and the sacral fields are usually adjusted at an angle of about 50 degrees to the longitudinal axis of the body in order to concentrate the rays as much a possible upon the tumor. The construction of the authors' apparatus provides for its use in the abdominal and sacral fields, but not for the perineal field, where there is no special difficulty of adjustment. The variably high seat of rectal tumors has been taken into consideration in the construction of the apparatus, which was primarily utilized for the radiation of carcinoma of the rectum. However, this does not exhaust its range of applicability, for this apparatus also proved very serviceable in the treatment of other tumors situated on or near the surface of the trunk, especially when it was desired to reach the tumor from the opposite side of the body, as for example, in a dorsal field of mammary carcinoma. The apparatus is based on the construction of a triangle by means of which the length and direction of the central ray can be accurately adjusted.

GROEDEL. New form of orthodiagraph. *Fortscrb. a. d. Geb. d. Röentgenstrablen*, xxvii, Hft. 2.

The author describes the construction of an apparatus which has not so far been manufactured by German firms on account of the existing financial situation. The range of utilization of a similar cross-section designer (the construction of which must be looked up in the original) would be very extensive. In the first place, it would serve for discovering the cross-section of the thorax, with that of the heart and the large vessels, at different levels. In the same way, it would also be possible to ascertain the depth and extent of pulmonary processes, as well as the position and depth of foreign bodies in any part of the body, etc.

MAXIMOW, ALEXANDER A. Studies on the changes produced by roentgen rays in inflamed connective tissue. *J. Exper. M.*, Mar. 1, 1923, xxxvii, 319.

The author, who conducted his work in the Hull Laboratory of Anatomy of the University of Chicago, found very little known about the action of *x*-rays upon living substance. He began his experimental work in 1919.

The action of *x*-rays upon inflamed tissue manifests itself in the first place by a considerable depression of the usual reaction on the part of the fibroblasts. Under normal circumstances these elements begin to divide mitotically during the first twenty-four hours and soon form a layer of new connective tissue, surrounding the foreign body. After treatment with *x*-rays they remain idle, do not multiply at all, or start very late and often the division is abnormal. They undergo a high degree of pathological hypertrophy of protoplasm and nucleus. Instead of mitosis often amitotic constrictions appear in the nucleus. The capacity for collagen formation seems also to be lost.

Simultaneously with these changes of the fibroblasts an intensive edema of the connective tissue surrounding the foreign body is to be noted and in the immediate neighborhood of the latter a thick layer of net-like clotted fibrinous exudate is formed.

No distinctive qualitative changes could be found in the leucocytes and polyblasts. Degeneration was present here only to the same extent as in common aseptic inflammation. But first the rate and the duration of the emigration of all the cells coming from the blood were increased, and secondly there was always a distinct delay in the process of the common transformations usually undergone by the polyblasts on the field of inflammation. The transformation of the polyblasts into fixed resting forms seems above all to be delayed. Therefore, even in late stages, the tissue is overcrowded with the granular special leucocytes and with mostly young, lymphocyte-like polyblasts, whereas in the early stages the local resting wandering cells only slowly undergo mobilization.

Furthermore, in the blood-vessels swelling of the endothelial cells with fragmentation of the nuclei and, in the striated muscles, degeneration of the fibers can be detected. In the latter there occur partly typical coagulation necrosis, partly atrophy, accompanied by loss of striation, separation of fibrillae from one another, relative increase of sarcoplasm, and amitotic division of nuclei.

What the ultimate result of all these changes would be, is as yet not clear. In the case of longest duration, in which sixty days had elapsed since the last exposure, no distinct difference could be found between the exposed and control preparations. Thus one might believe that the cell injuries caused by the *x*-rays, and above all the inability of the fibroblasts to multiply and to elaborate collagen, are again repaired in due time. However, my material is decidedly inadequate in this respect and several cases of long duration should be examined.

It is surprising that the results obtained seem not to agree with the predominating views on the action of *x*-rays on cells. Apart from the endothelium of the blood-vessels, of all the cells present in the field of inflammation the fibroblasts undoubtedly are to be considered as the elements most highly differentiated in a specific sense. I have shown that, as a rule, they do not round up in inflammation and do not produce ameboid cells, but remain unchanged in morphology and, through mitotic division, give rise to the new connective tissue. On the other hand, there can be no doubt that the lymphocytes and the polyblasts are to be looked upon as relatively indifferent cells, endowed with great prospective potencies of development. Thus it might be expected that just the lymphocytes of the inflamed area would be affected in the first place by the rays, as they are in the blood-forming organs, and that the fibroblasts, on the contrary, would be refractory.

But the facts have proved that the most conspicuous and constant changes concern the fibroblasts. They are paralyzed for a long time and made unable to build up new tissue. The fibrinous exudate and the edema might perhaps also depend partly on a direct injury of the colloidal intercellular substance, partly on changes of the endothelium of the blood-vessels, cells which are again to be considered as highly differentiated.

Noteworthy signs of degeneration could not be found in the lymphocytes and polyblasts. But here again the necessary early stages, one to three days after the last exposure, were not available; it is possible that the emigrated lymphocytes are destroyed by the *x*-rays rapidly, in an explosive manner, in twenty-four to forty-eight hours, as in the lymph-nodes or the thymus, or as described by Pautrier in the chronically inflamed tissue of the skin in mycosis fungoides. Their remains might be quickly resorbed and after the last exposure new lymphocytes would have time to emigrate out of the blood-vessels and to pass to the tissue. However, if we take this for granted, there remains another inexplicable fact, concerning the local resting wandering cells—their close genetic relationship with the lymphocytes is beyond doubt and yet exposure to *x*-rays does not seem to affect them. In this connection it may be stated that Soper found that the reticulo-endothelial apparatus, whose cells correspond to the resting wandering cells, is stimulated by small doses of *x*-rays and paralyzed by large doses. For deciding these problems further investigations are necessary.

WELS. The diagnosis and mechanism of idiopathic elevation of the diaphragm. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xxviii, No. 2.

The author reports a case in a seven-year-old girl, in whom it was demonstrated by means of a pneumoperitoneum that no hernia, but eventration, was present. If the diaphragm lies high, pneumoperitoneum furnishes practically certain proof as to whether the diaphragm throughout its entire extent is entirely free from the walls of the gastrointestinal segment lying in the thoracic cavity. The gas, insufflated into the abdominal cavity presses on the upper gastric wall, between this and the diaphragm, producing an effect opposite to that of gas within the stomach. This makes possible the fluoroscopic demonstration of the separation between the two organs. Various conditions might interfere, such as extensive adhesions between the stomach and the diaphragm, also such a high grade of gastric pneumatosis that the pressure within the stomach is sufficient to overcome the intraperitoneal pressure which can be applied within the limits of the patient's tolerance. The first condition has not been found in any cases coming to autopsy; whether the latter condition can occur can be determined only on further use of the method. In diaphragmatic hernia, distinction must be made between true and false hernia. The conditions in true hernia have not been determined by this method. In false hernia, an easily recognized pneumothorax occurs on induction of pneumoperitoneum. Of especial importance is the often large amount of air in the stomach, which Hoffman believes to be due to the inefficient functioning of the diaphragm in these cases. Accordingly this

collection of air in the stomach has a further unfavorable influence on the eventration by pressure upon weakened diaphragmatic muscle. The author does not agree with this opinion. The chief etiological factor in eventration is the negative pressure within the thorax during thoracic growth, which the less resistant diaphragm follows more easily than the elastic lungs. The gastric flatulence is not the cause but the result of eventration.

SGALITZER, MAX. The roentgen diagnosis of disease of the esophagus, especially esophageal cancer. *Arcb. f. klin. Cbir.*, cxvi, 53.

The article is based on a large number of cases from the Eiselberg Clinic and illustrated with numerous roentgenograms. Among the conclusions are: The frontal view of the thoracic portion of the eosphagus is adapted to showing a great variety of pathological conditions. A similar techniqe is used for the roentgenological examinations of the trachea from the lateral view. In incomplete stenosis due to tumor, a plate from the frontal view with the patient lying down is sufficient to localize the lesion; then when the opaque meal is swallowed, the degree, length, and form of the stricture is determined: it indicates also a beginning perforation of the tumor into the respiratory passages. Tumors of the esophagus in the upper thoracic portion usually cause more or less definite changes in the position and shape of the respiratory passages. The frontal view of the esophagus makes it possible to demonstrate tumors of the esophagus without a contrast meal, thus directly showing their position and extent. This direct demonstration of these tumors is due to the fact that from this position they show a greater density than the air-containing lungs. The tumors of the lower thoracic portion of the esophagus, which usually pulsate with the heart, can be demonstrated only shortly after meals. With further improvement of the technique of operations on the esophagus, indications for radical operation can be determined on the basis of the situation and size of the tumor, as well as its relation to neighboring organs, as shown by the roentgen rays, with due regard to the general condition of the patient. The degree of stenosis present shows no relation to the size of the tumor; and can therefore not be taken as an indication or contraindication for radical operation.

TANTURRI, DOMENICO. Radium therapy of rhinoscleroma. *Actinoterapia*, 1921, ii, 24.

The author reports a case of extensive rhinoscleroma that entirely covered both nasal passages and extended toward the pharynx. Roentgen-ray treatment, continued for a long time, was without result. In October, 1919, radium treatment was begun after a preliminary excision of a segment of the growth to give space for the radium. In the course of four weeks a total dosage of 1,226 mg. hrs. was given followed by complete disappearance of the rhinoscleroma and no recurrence in two years.

BECK. Radium treatment of hemangioma. *Münchcn. med. Wchnschr.*, 1921, No. 39, p. 1248.

The author reports 3 cases of hemangioma still under treatment with radium, and 3 other cases in which treatment was completed. The result in all was very good. The course and action of the radiation was such that in the first eight to fourteen days there was a marked increase in the volume of the angioma. Also, the skin and the mucous membrane reacted to the intensive radiation, by an inflammatory reddening and occasionally a superficial erosion, which, however, disappeared within a reasonably short period without any special treatment. This inflammatory reaction caused no serious injury to the skin, since only one case showed a scar, and no other changes in the skin were demonstrable. The author advises no application of the radium within the tumor, since percutaneous, well-filtered radiation gave equally good and perhaps better results. After fourteen days more the tumor became definitely smaller in each case. After a few weeks more, they remained stationary. The radiation was long-continued and intensive. The filtration consisted of ½ mm. lead, 1 to 2 mm. rubber, and several layers of paper or cellulose; therefore only the gamma rays, and of these, only the hardest rays, were used. The radiation must be carried out at first until the tumor enlarges, thus giving a convenient measure for dosage.